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Action plan for instream flow determinations in Montana

DETERMINATION OF INSTREAM FLOWS IN MONTANA: AN ACTION PLAN

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Montana Department of Fish, Wildlife and Parks

December 1979

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ACTION PLAN FOR
INSTREAM FLOW DETERMINATIONS
IN MONTANA

by

Montana Department of Fish, Wildlife & Parks
Ecological Services
and
Fisheries Divisions
Helena, Montana 59601

December, 1979

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LONG-RANGE PLAN FOR INSTREAM FLOWS

Montana is one of the few western states which has the ability to allocate a portion of its surface waters to remain instream for fish and wildlife purposes. Section 85-2-316 of the Montana Water Use Act outlines the procedure for the reservation of waters of the state. The reservation process has just been completed for the Yellowstone River Basin. The Department of Fish, Wildlife & Parks took an active part in these proceedings in defense of instream flows for fish and wildlife. As a result, the Department has been granted an instream allocation amounting to 5.5 million acre-feet of water at Sidney, Montana.

Much remains to be done in regard to maintaining the integrity of the Yellowstone allocations. Legal challenges must be met, allocations must be substantiated and defended during the review period, and additional biological and flow data obtained to comply with certain conditions of the order. In addition, other basins have been identified which are: (1) particularly vulnerable to dewatering, (2) areas of high aquatic resource value, or (3) unique or contain features of special interest. The basins selected for further work on instream flows based on the above criteria are as follows:

(1) Upper Clark Fork River (from the headwaters downstream to Bonner);
(2) Upper Missouri River (from headwater tributaries downstream to Canyon Ferry Dam);
(3) Middle Missouri River (from Fort Benton to Fort Peck Reservoir).

The remaining instream flow studies can be grouped in the following categories:

(1) Water adjudication under provisions of Senate Bill 76.
(2) Additional Yellowstone River tasks.

All items are scheduled to start during the summer of 1979 - the upper Clark Fork study is scheduled for completion in 2 years, the middle Missouri in 3 years, and the upper Missouri in 4 years. The filing deadline for streams covered under provisions of Senate Bill 76 is January 1, 1982. The accomplishment of the goals outlined is dependent on securing adequate sources of funding.

Upper Clark Fork

The Clark Fork of the Columbia River has its headwaters in Montana near the city of Butte and flows in a northwesterly direction, leaving the state near Thompson Falls. In the past, the Clark Fork has periodically suffered severe degradation from industrial pollution spills, often resulting in fish kills and bottom substrate damages. As a result, the aquatic populations have historically been maintained at levels well below the carrying capacity of the stream.

Recent efforts at industrial pollution abatement in upstream areas have considerably improved the quality of water. Fish populations have responded dramatically and, in some sections, rival those found in many of our "Blue Ribbon" streams. Even though the Clark Fork has recovered dramatically from past abuses, certain reaches are exhibiting signs of stress from chronic temperature, nutrient and dissolved oxygen problems with increases in severity as streamflows decrease. Certain segments of the Clark Fork are now in a borderline flow condition during the low flow summer months. Additional dewatering could severely impact these segments.

A major water source for the upper river is the discharge from Anaconda's waste treatment ponds. The 1983 zero discharge requirement imposed on Anaconda could significantly impact the entire upper Clark Fork.

The Clark Fork currently has no instream flow protection. In view of the vulnerable position of the upper Clark Fork, it is felt that a reservation of flow for this section of river should be the Department's next priority.

The reach of Clark Fork considered for reserving flows is from the town of Bonner upstream to the headwaters. This does not include the Blackfoot or Bitterroot rivers. The Blackfoot currently enjoys a measure of protection from a 1971 instream flow filing under provisions of Section 89-801, R.C.M. 1947. The special problems of the Bitterroot River can probably best be handled by procedures other than a reservation of flows.

Initial biological investigations have begun and cross-sectional sites established, surveyed and data prepared for computer analyses. A productivity/nutrient loading study has begun and an assessment of the recreational use in that portion of the drainage is completed. The tentative completion date for the Clark Fork instream studies is the spring of 1981.

Upper Missouri

The Missouri River drainage above Canyon Ferry Dam contains some of the best wild trout waters in the nation. Many of the smaller streams supply water flows necessary to maintain the fisheries values in the larger streams and rivers. These smaller streams also provide locally important fisheries.

There are considerable BLM and Forest Service lands which border on major trout rivers and tributary streams in the upper Missouri. The reservation process will directly affect management in many of these areas, and involvement of the above agencies will be an important part of the process.

Since the Upper Missouri drainage is being considered as a likely candidate for one of the next water allocation areas, it is imperative to assess the current situation and identify areas needing further work in the future. Currently, in the Missouri drainage above Canyon Ferry Dam, flow recommendations for the upper Missouri River Basin Level B planning effort have been made for the Jefferson, Madison, Gallatin, East Gallatin, West Gallatin, Big Hole, Beaverhead and Ruby rivers. Several tributaries in the Gallatin Forest have had, or are in the process of having, the IFG-4 method completed to identify flow needs.

There are approximately 70 other tributaries in the study area where either biological and/or instream flow studies are needed. Goals of the present investigations would be (1) to determine fish populations in approximately 50 tributaries where adequate data are not available, and (2) to use the IFG-4 or wetted perimeter methodology to determine fishery flow needs in approximately 70 tributaries of the Missouri above Canyon Ferry. The study will be conducted over a 4-year period beginning May 1979 and terminating with a final report in February 1984.

Middle Missouri

Under legislation signed by President Ford in October 1976, a 149-mile reach of the Missouri River in northcentral Montana was incorporated into the National Wild and Scenic Rivers system. A portion of this legislation requires that the Bureau of Land Management determine instream flows required to maintain the river, commensurate with the purposes of the Act. This determination will be based, in part, on instream flow requirements needed to maintain the fishery resource and its associated aquatic habitat.

The Montana Department of Fish, Wildlife & Parks is currently conducting a fisheries inventory and planning study in the 149-mile reach of the Missouri River included in the aforementioned legislation. The Department's study efforts, initiated on October 1, 1975, parallel to some extent the effort to be made by the Bureau of Land Management on instream flow quantification. In view of the difficulty of quantifying instream flow needs for fisheries in a river such as the Missouri, it was deemed beneficial for the Bureau of Land Management and the Montana Department of Fish, Wildlife & Parks to cooperate in developing a suitable methodology to provide consistent results. The study is scheduled to begin during spring 1979 and is designed to run for 3 years, although funding is on an annual basis.

Water Adjudication Under Provisions of Senate Bill 76

Under provisions of an earlier act (Section 89-801 passed by the 1969 Montana Legislature), the so-called Murphy's Law, the Department of Fish, Wildlife & Parks was able to file for instream water rights on 12 high-quality trout streams. An important immediate goal of our instream flow program is to reaffirm our instream flow needs for these 12 streams.

As the result of a decision concerning a contested water right on one of these streams (Smith River), it was determined that the Department of Fish, Wildlife & Parks did indeed have an instream right, but it is unquantified at the present time. Consequently, the instream flow numbers must be quantified for all our "Murphy's" streams before they can become effective.

The passage of Senate Bill 76 by the 1979 Montana Legislature lends a certain urgency to the quantification of our filed rights on the 12 streams. Senate Bill 76 is entitled "An Act to Adjudicate Claims of Existing Water Rights in Montana".

Basically, this Act establishes a procedure for a centralized filing of all water rights prior to enactment of the 1973 Water Use Act. In addition, a system of water courts would be provided for the actual adjudication process.

In 1970 and 1971 the Department of Fish, Wildlife & Parks filed for instream water rights on all or portions of Big Spring and Rock Creeks, and the Blackfoot, Flathead including North Fork, Gallatin, West Gallatin, Madison, Missouri, Smith, Yellowstone, Middle Fork Flathead, and South Fork Flathead rivers. Under Senate Bill 76, failure to refile a claim will result in the presumption that the water right or claimed water right has been abandoned. The Department, therefore, is compelled to file on and substantiate the flows originally claimed on the above 12 streams under Section 89-801, R.C.M. 1947.

The quantification of the Department's existing instream rights on the 12 streams has been given high priority. The deadline for refiling to confirm existing rights is January 1, 1982. A specific array of projects necessary to accomplish this goal and an estimate of costs are presented in a later section.

Additional Yellowstone River Tasks

The Board of Natural Resources and Conservation signed the Order Establishing Water Reservations on the Yellowstone River on December 16, 1978. When the Board granted a water reservation to a particular applicant, they frequently attached stipulations or conditions to the reservation which have to be met to keep the reservation valid. Fulfillment of these conditions is primarily the responsibility of the Department of Fish, Wildlife & Parks since we are the major holder of instream reservations in the Yellowstone Basin. The projects planned to meet these conditions and an estimate of costs are presented in a later section.

A more thorough discussion of all instream flow projects in need of supplementary funding is presented along with the proposed budgets in the following sections.

UPPER MISSOURI RIVER DRAINAGE INSTREAM FLOW DETERMINATIONS

Section 85-2-316 of the Montana Water Use Act outlines a procedure for the reservation of waters of the state for instream uses. In anticipation of the reservation process being applied to the Missouri River drainage upstream of Canyon Ferry Reservoir, the Montana Department of Fish, Wildlife and Parks is collecting biological, hydraulic, streamflow and recreational data in the drainage in order to quantify and support instream flow requests.

The Missouri River drainage upstream of Canyon Ferry Reservoir (Figure 1) is characterized by an abundance of clear, cold-water tributaries which support nationally renowned wild trout fisheries. Portions of the Big Hole, Gallatin and Madison Rivers and the mainstem Missouri have been classified as "Blue Ribbon" in recognition of their high fishery, recreational, and aesthetic values.

The basic character of the drainage has changed in the past 100 years. The free-flowing nature of many of the tributaries and portions of the mainstem has been altered by several dams which were constructed for flood control, power generation, and irrigation.

Native wildlife populations associated with the drainage also experienced change over time. Gone are the grizzly and bison from historic bottomland ranges. Elk, while thriving in mountain areas, have had their bottomland populations significantly reduced. Disruption of sagebrush areas has adversely affected sage grouse populations while the introduced ring-necked pheasant and Hungarian partridge flourish with a modest degree of agricultural activity. The white-tailed deer, a species highly adapted to agricultural areas, has recently extended its range into many areas of the upper Missouri drainage.

The fish fauna has also experienced change. The native cutthroat trout and arctic grayling which dominated much of the cold-water habitat have been replaced by rainbow, brown and brook trout, introduced to the drainage in the late 1800's and early 1900's. Of the native salmonids, only the mountain whitefish has prospered. Remnant populations of Missouri River cutthroat trout still occur in a few small tributaries and a dwindling arctic grayling population is found in the upper Big Hole drainage. This grayling population represents the only major remaining stream dwelling population in the contiguous United States south of Alaska.

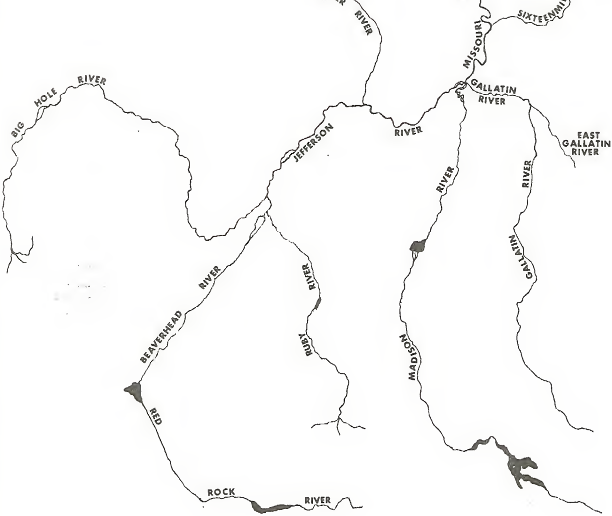

FIGURE 1. Map of the Missouri River drainage upstream of Canyon Ferry Reservoir.

The trout fishery of the many cold-water impoundments is primarily maintained by annual plants of juvenile hatchery rainbow trout. These impoundments also provide a sport fishery for other species such as brown trout, kokanee, yellow perch, and burbot.

In addition to providing a nationally renowned trout fishery, the Missouri drainage above Canyon Ferry Dam provides other recreational opportunities. All forms of recreational boating from white water kayaking, canoeing and floating on the headwater tributaries to power boating on the mainstem above Canyon Ferry Reservoir are popular. The drainage also supports diverse populations of huntable game species ranging from common game-birds such as ring-necked pheasant, Hungarian partridge, and sharp-tailed grouse of the river bottomlands to big game trophies such as elk, mountain lion and big horn sheep on the adjacent mountainsides.

The high quality of water-based recreation in the basin is dependent on adequate stream flow. Consumptive uses are often in conflict with instream purposes. In some areas, excessive consumptive demands have severely depleted certain stream sections and adversely affected the recreational potential of those areas. The maintenance of the existing high quality recreation can only be assured by securing sufficient water for instream purposes.

The Missouri River drainage upstream of Canyon Ferry Reservoir is divided into eight subdrainages consisting of the Gallatin, East Gallatin, Madison, Missouri, Jefferson, Big Hole, Beaverhead and Ruby Rivers. Streams in these subdrainages in which instream flow needs will be quantified are listed in Table 1 and located in Figures 2 through 7. Those streams in which instream flow determinations are of high priority have also been determined. Factors considered when separating high and lower priority streams include: (1) stream size, (2) status of existing irrigation depletions with severely dewatered streams being assigned a low priority, (3) sport fishing value, (4) proposed water development projects, (5) presence of critical spawning and nursery areas, (6) presence of fish species of special concern (arctic grayling and cutthroat trout), (7) value for waterfowl and other wildlife, and (8) habitats of special concern (spring creeks).

Table 1. A listing of the streams of the Missouri River drainage above Canyon Ferry Reservoir in which instream flow needs will be quantified and the type of data presently available for each stream.

				Existing Cross-Sectional Data	Existing Fish Survey Data	Existing Fish Pop. Estimates	Existing Temp. Data	Existing Flow Data
GALLATIN RIVER DRAINAGE								
Baker Creek	1N	3E	S12		x			
Spanish Creek	4S	4E	S18					
South Fork Spanish Creek *	4S	3E	S32	x[1]	x			
Hell Roaring Creek*	4S	4E	S4&5	x[1]				
Squaw Creek	4S	4E	S34	x[1]	x			
Swan Creek *	5S	5E	S25	x[1]	x			
Moose Creek *	6S	5E	S06		x			
Portal Creek*	6S	4E	S13		x			
West Fork	6S	4E	S32	x[1]	x			
North Fork*	6S	3E	S35		x			
Middle Fork	6S	3E	S35		x			
South Fork	6S	4E	S31		x			
Porcupine Creek	7S	4E	S16		x			
Beaver Creek*	7S	4E	S17		x			
Buck Creek *	8S	4E	S04	x[1]	x			
Taylor Fork	9S	4E	S11	x[1]	X			
Cache Creek	9S	3E	S4&9	x[1]	x			
South Cottonwood Cr.*	3S	5E	S34	x[1]				
Gallatin R. (mouth-E. Gallatin R.)					x		x	x
Gallatin R. (E. Gallatin R.-Spanish Cr.)				x	x	x	x	x
Gallatin R. (Spanish Cr.-YNP Boundary)					x	x		
EAST GALLATIN RIVER DRAINAGE								
Rocky Creek	2S	6E	S06		x	x		
Sourdough Creek	2S	6E	S06		x	x		
Sourdough Creek	3S	5E	S21	x[1]				
Bridger Creek	1N	7E	S29					
Bridger Creek*	1S	6E	S31		x			
Hyalite Creek	1N	5E	S32		x			
Hyalite Creek	3S	5E	S25	x[1]				X
Reese Creek	1N	5E	S11		x			
Ben Hart Creek	1N	4E	S11					
Thomspon Creek	1N	4E	S13		x	x		
E. Gallatin R. (mouth-Thompson Cr.)				x	x	x		
E. Gallatin R. (Thompson Cr.-Hyalite Cr.)				x	x	x		
E. Gallatin R. (Hyalite Cr.-Headwaters)					x	x		x

Table 1 continued.

				Existing Cross-Sectional Data	Existing Fish Survey Data	Existing Fish Pop. Estimates	Existing Temp. Data	Existing Flow Data
BIG HOLE RIVER DRAINAGE								
Willow Creek*	4S	9W	S26					
Trapper Creek*	2S	9W	S34					
Camp Creek	2S	9W	S26					
Moose Creek	1S	9W	S33					
Canyon Creek	1S	9W	S32		x			
Divide Creek	1S	9W	S08					
Deep Creek	2N	12W	S29		x			
French Creek	2N	12W	S16		x			
Pintlar Creek	1N	14W	S23		x			
LaMarche Creek	2N	13W	S34		x			
Fishtrap Creek	1N	13W	S04		x			
Mussigbrod Creek	1N	16W	S09		x			
North Fork Big Hole	1S	15W	S33		x			
Trail Creek	2S	17W	S23		x			
Ruby Creek	3S	17W	S15		x			
Steel Creek*	2S	15W	S34		x			
Big Lake Creek*	4S	16W	S32		x			
Miner Creek	5S	15W			x			
Governor Creek	6S	14W			x			
Warm Springs Creek	5S	14W			x			
Wise River	1S	12W	S19		x			x
Pattengail Creek	2S	12W	S10		x			
Swamp Creek	2S	15W			x			
Francis Creek	3S	15W						
Johnson Creek	1S	16W						
Big Hole River (Mouth-Old Divide Dam)				x	x	x	x	x
Big Hole River (Old Divide Dam-Pintlar Cr.)				x	x	x		
Big Hole River (Pintlar Cr.-Headwaters)				x	x	x		
BEAVERHEAD RIVER DRAINAGE								
Poindexter Slough	7S	9W	S26		x	x		
Blacktail Creek	9S	8W	S14		x	x		
East Fork Blacktail Creek	11S	6W	S04		x	x		
Grasshopper Creek	8S	10W	S26		x			
Horse Prairie Creek	10S	11W	S11		x	x		
Bloody Dick Creek	9S	15W	S15		x	x		
Red Rock River (Mouth-L. Red Rock Lake)				x	x	x		x
Red Rock River (L. Red Rock Lake-Headwaters)					x			
Big Sheep Creek	13S	10W	S35		x	x		x
Odell Creek	14S	2W	S10		x			
Tom Creek	14S	1W	S23		x			

Table 1 continued.

				Existing Cross-Sectional Data	Existing Fish Survey Data	Existing Fish Pop. Estimates	Existing Temp. Data	Existing Flow Data
BEAVERHEAD RIVER DRAINAGE (Continued)								
Hellroaring Creek	14S	1E	S14		x			
Antelope Creek	14S	1E	S16		x			
Corral Creek	14S	1E	S16		x			
Clover Creek	14S	5W	S02		x			
Long Creek*	14S	4W	S08		x			
Beaverhead River (Mouth-Anderson Lane)				x	x	x	x	x
Beaverhead River (Anderson Lane-Grasshopper Cr.)				x	x	x	x	x
Beaverhead River (Grasshopper Cr.-Clark Canyon Dam)				x	x	x	x	x
RUBY RIVER DRAINAGE								
Warm Springs Creek	9S	3W	S21					
Middle Fork Ruby	11S	3W	S05		x	x		
West Fork Ruby	11S	3W	S05		x	x		
East Fork Ruby	11S	3W	S05		x	x		
Ruby River (Mouth-Sheridan)				x	x	x		
Ruby River (Sheridan-Ruby Dam)				x	x	x		
Ruby River (Ruby Dam-Headwaters)					x	x		x
JEFFERSON RIVER DRAINAGE								
Boulder River (Mouth-Big Spring)				x	x	x	x	
Boulder River (Big Spring-Little Boulder River)					x	x	x	x
Boulder River (Little Boulder River-Bison Cr.)					x	x	x	
Boulder River (Bison Cr.-Headwaters)					x	x		
South Boulder River	1S	3W	S22		x			
Willow Creek	1N	1E	S19		x			
Whitetail Creek	2N	4W	S09					
Jefferson River (Mouth-Mayflower Bridge)				x	x	x		x
Jefferson River (Mayflower Bridge-Headwaters)				x	x	x	x	x
MISSOURI RIVER DRAINAGE								
Crow Creek[2/]	6N	1E	S30					
Dry Creek[2/]					X			
Deep Creek[2/]	7N	3E	S36					
Duck Creek[2/]	8N	2E	S03					
Confederate Gulch Creek	8N	2E						
Beaver Creek	9N	1E	S29					
Sixteenmile Creek	4N	3E	S07	x	x	x		
Missouri River (Canyon Ferry Reservoir-Headwaters)					x	x		x

Table 1 continued.

				Existing Cross-Sectional Data	Existing Fish Survey Data	Existing Fish Pop. Estimates	Existing Temp. Data	Existing Flow Data
MADISON RIVER DRAINAGE								
Cherry Creek*	2S	1E	S36					
Hot Springs Creek*	3S	1E	S09					
North Meadow Creek	4S	1W	S34					
South Meadow Creek*	4S	1W	S34					
Jack Creek*	5S	1W	S24		x			x
O'Dell Creek	5S	1W	S27		x	x		
Blaine Spring Creek	7S	1W	S06		x			
Indian Creek	8S	1E	S36					
Ruby Creek*	9S	1W	S12		x			
Squaw Creek	10S	1E	S33					
West Fork Madison	11S	1E	S10		x	x		
Standard Creek	10S	1E	S33					
Grayling Creek	12S	5E	S08					
Duck Creek*	12S	5E	S22					
Cougar Creek*	12S	5E	S22					
South Fork Madison	13S	4E	S24	x1/	x	x		
West Fork Denny Creek*	13S	4E	S17	x1/				
Watkins Creek*	12S	4E	S07&18	x1/				
Antelope Creek	12S	1E	S36					
Cabin Creek	11S	3E	S15					
Beaver Creek	11S	3E	S21					
Madison River (Mouth-Ennis Dam)				x	x	x	x	x
Madison River (Ennis Dam-McAtee Bridge)					x	x	x	x
Madison River (McAtee Bridge-Quake Lake)				x	x	x		x
Madison River (Quake Lake-Hebgen Dam)								x
Madison River*(Hebgen Dam-YNP Boundary)					x			x

* Lower priority stream

1/ IFG4 data being collected by USFS

2/ Status presently unknown

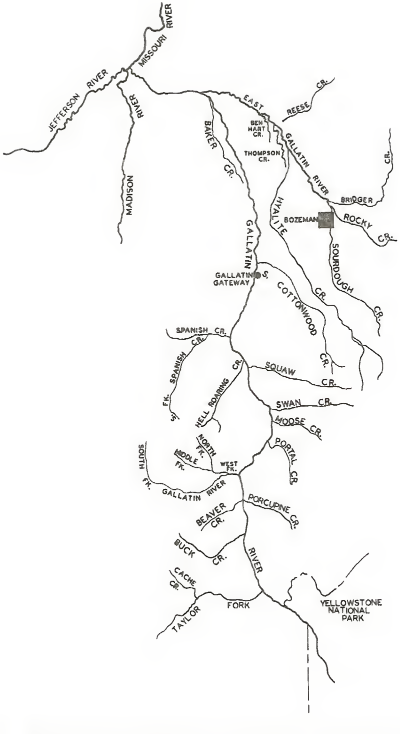

FIGURE 2. Map of the Gallatin and East Gallatin River drainages.

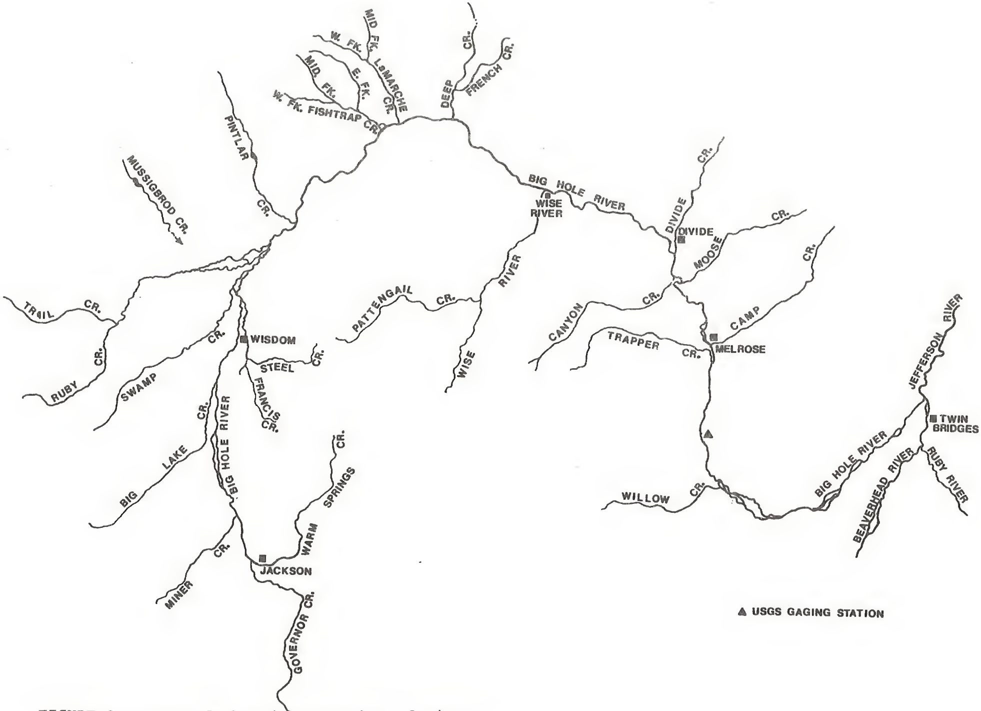

FIGURE 2a. Map of the Big Hole River drainage.

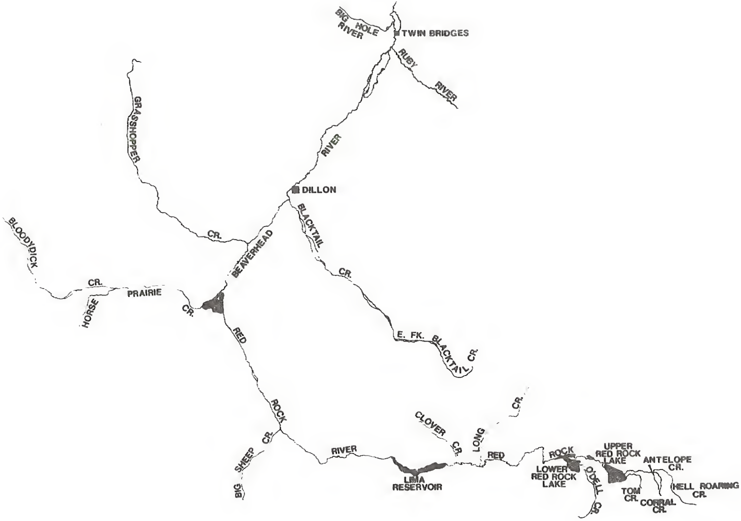

FIGURE 3. Map of the Beaverhead River drainage.

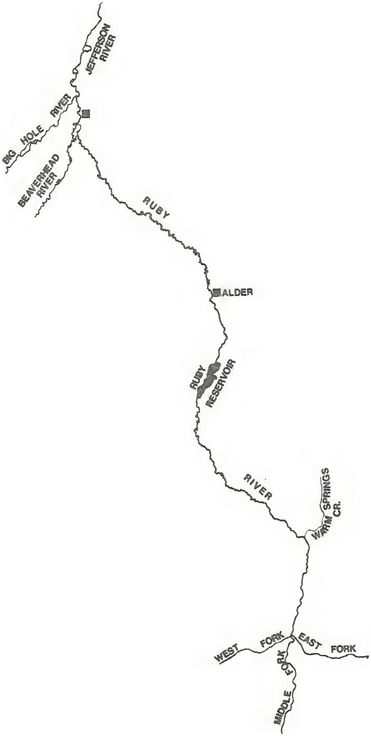

FIGURE 4. Map of the Ruby River drainage.

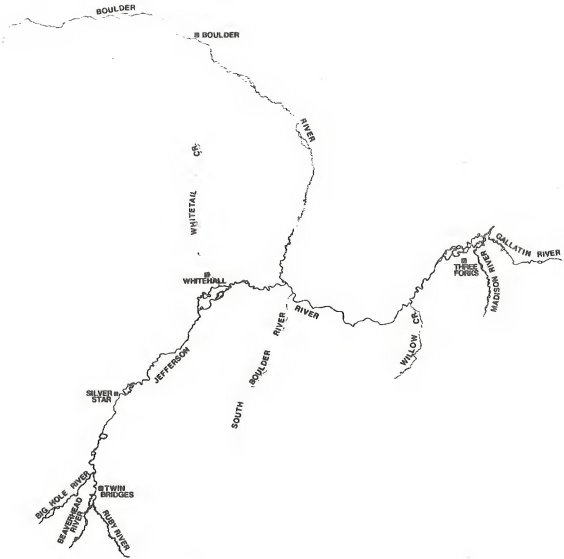

FIGURE 5. Map of the Jefferson River drainage.

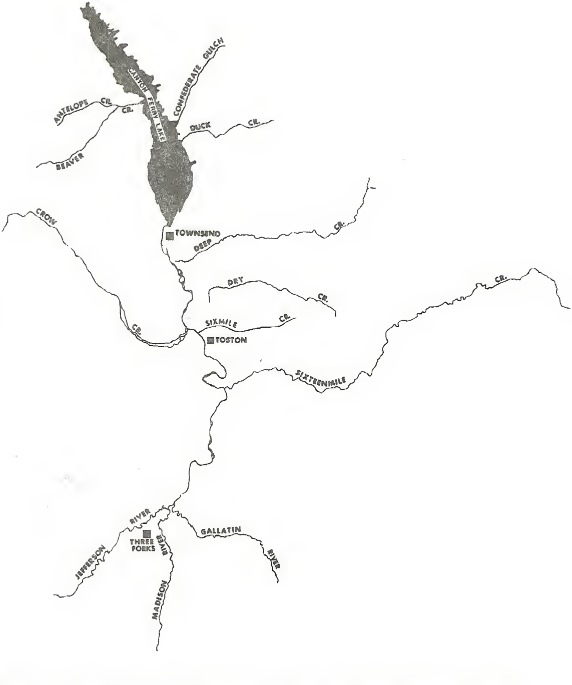

FIGURE 6. Map of the Missouri River between Canyon Ferry Reservoir and the headwaters at Three Forks.

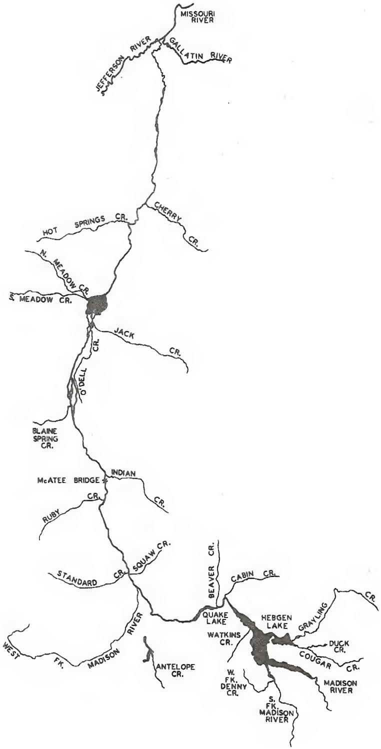

FIGURE 7. Map of the Madison River drainage.

Existing Data

Preliminary flow recommendations have already been made for reaches of the Missouri, Gallatin, East Gallatin, Madison, Big Hole, Jefferson, Beaverhead, Ruby, Red Rock and Boulder Rivers and Sixteenmile Creek for the Upper Missouri River Basin Level "B" planning effort (Montana Department of Fish and Game, 1979). This report addresses specific instream flow requirements for the selected streams utilizing long-term fish population data, physical stream channel measurements, predictive hydraulic programs and existing biological data wherever possible. Gaps in biological and stream flow data have been identified as well as existing resource conflicts. On streams where little biological or stream flow data currently exist, the instream flow recommendations may be subject to change as additional data become available.

Fish population, cross-sectional (hydraulic), temperature and flow data have already been collected for some of the streams considered for instream flow determinations. A summary of this available data (Table 1) shows that existing data is primarily confined to the larger waterways and almost entirely lacking for the smaller streams and creeks. Future data collection will primarily be confined to the smaller waterways where the data needs are greatest.

Methods

The following procedures will be used to obtain the data needed to derive and support instream flow needs.

I. The status of existing fish populations will be determined by estimating numbers and biomass in selected stream reaches during the summer and fall months when flows are lowest. The Petersen mark-recapture method will be used. On the smaller tributaries estimates will be obtained for 1,000-ft sections while sections as long as 5-7 miles may be needed on the larger waterways such as the Missouri and Jefferson Rivers. On streams where the numbers of trout are too low to obtain accurate estimates, survey data will be used.

II. The instream flow needs for selected stream reaches will be quantified. Recommendations will be made for two periods during the year, the high and low flow periods. Approaches to be used for each period are discussed separately.

A. High Flow Period - Dominant Discharge/Channel Morphology Concept

Several major components of aquatic habitat in river systems are related to the physical features and form of the river channel itself. Over time, aquatic populations have adapted and thrived within the physical constraints of channel configuration and flow.

It is generally accepted that the major force in the establishment and maintenance of a particular channel form is the annual flood characteristics of the river. Most streams and rivers in the Missouri drainage in Montana which are not regulated are characterized by an annual spring high water period which normally occurs during May and June and results from snowmelt in the mountainous headwaters. Lowland prairie streams in the eastern part of the state, which lack mountain headwater areas, have a high water period which occurs earlier and is the result of lowland snowmelt and runoff. Annual spring flow conditions on unregulated streams are heavily dependent upon snowpack and its rate of thawing. On regulated streams, the occurrence and magnitude of the high water period may vary depending upon reservoir operation and storage capacity.

The major functions of the high spring flows in the maintenance of channel form are bedload movement and sediment transport. It is the movement of the bed and bank material and subsequent deposition which forms the mid-channel bars and subsequently the islands. Increased discharge associated with spring runoff also results in a flushing action which removes deposited sediments and maintains suitable gravel conditions for aquatic insect production, fish spawning and incubation.

Reducing the high spring flows beyond the point where the major amount of bedload and sediment is transported would interrupt the ongoing channel processes and change the existing channel form and bottom substrates. A significantly altered channel configuration would affect both the abundance and species composition of the present aquatic populations by altering the existing habitat types.

Several workers (Leopold, Wolman and Miller, 1964; U.S. Bureau of Reclamation, 1973; and Emmett, 1975) adhere to the concept that the form and configuration of river channels are shaped by and designed to accommodate a dominant discharge. The discharge which is most commonly referred to as a dominant discharge is the bankfull discharge (Leopold, Wolman and Miller, 1964; Emmett, 1975). Bankfull discharge is defined as that flow when water just begins to overflow onto the active floodplain.

Bankfull discharge tends to have a constant frequency of occurrence among rivers (Emmett, 1975). The recurrence interval for bankfull discharge was determined to be 1.5 years and is in close agreement with the frequency of bankfull discharge reported by other studies (Leopold, Wolman and Miller, 1964; Emmett, 1972). The bankfull discharge for streams and rivers can be estimated by using the 1.5 year frequency peak flow.

It is not presently known how long the bankfull flow must be maintained to accomplish the necessary channel formation processes. Until studies further clarify the necessary duration of the bankfull discharge, a duration period of 24 hours was chosen. A gradual rising and receding of flows should be associated with the dominant discharge and the shape of the spring hydrograph should resemble that which occurs naturally. The dominant discharge is requested for that period when it normally occurs. Flows are increased from a base flow level to the dominant discharge in 2-week intervals at the 70th percentile flow level, corresponding to the natural timing of the high flow period.

The high flow months are the least likely periods to be affected by water depletions since withdrawals make up a significantly smaller percentage of the flow during spring runoff than during the low flow months of later summer and winter. It is likely that the high flow months can withstand certain withdrawals and not alter the basic functions of channel maintenance. The major threat to channel maintenance functions during the high flow period is large water storage projects which have the capability of capturing a large portion of the high flows for later release. The loss of the dominant discharge flow through mainstem impoundment projects can result in a drastically altered channel form.

B. Low Flow Period

For the low flow period, which normally occurs from July through April, two instream flow recommendations will generally be made for each stream reach. These recommended flows will maintain the high and low levels of aquatic habitat potential and are defined as follows:

High Level of Aquatic Habitat Potential - That flow regime which will consistently produce abundant, healthy and thriving aquatic populations. In the case of game fish species, these flows would produce abundant game fish populations capable of sustaining a good to excellent sport fishery for the size of stream involved. For rare, threatened or endangered species, flows to accomplish the high level of aquatic habitat maintenance would: 1) provide for high population levels to ensure the continued existence of that species, or 2) provide for flow levels above that which would adversely affect the species.

Low Level of Aquatic Habitat Potential - Flows to accomplish the low level of aquatic habitat maintenance would provide for only a low population abundance of the species present. In the case of game fish species, a poor sport fishery could still be provided. For rare, threatened or endangered species, their populations would exist at low or marginal levels. In some cases, this flow level would not be sufficient to maintain certain species.

One or more approaches will be used to derive flow recommendations during the low flow period. They include:

(1) Long-term Biological and Flow Relationships

This approach is limited to gauged reaches of the Big Hole, Madison, Gallatin and Beaverhead Rivers where long-term fish population data have already been collected. The flows in these reaches are altered either by dams or by irrigation withdrawals. The data show that seasonal variations in the standing crops of trout within each reach are correlated with seasonal variations in stream flow. From these data the flows that will maintain the high and low levels of aquatic habitat potential were derived.

(2) Short-term Biological and Flow Relationships

Biological data collected in a two to three year period can also be used to derive and/or support instream flow requests. Short-term studies can be used to determine those flows needed to maintain trout spawning and nursery areas, pass migrating fish, and maintain riffles, the primary food producing areas of a stream.

(3) Water Quality and Flow Relationships

The dewatering of a stream not only decreases the amount of space available for fish but also can lower the levels of dissolved oxygen, and increase water temperatures and levels of total dissolved solids, thereby lowering the quality of water and the capacity of a stream to support sensitive cold-water organisms such as trout. In streams where chemical and organic wastes are discharged, adequate dilution flows must be provided to meet state and federal water quality standards and to maintain conditions favorable for aquatic life. In many streams water quality is related to flow. If sufficient flows are provided, good quality water can be maintained and a trout fishery provided.

Water quality and flow relationships will be used to derive and/or support flow requests on waterways such as the lower reaches of the Big Hole, Jefferson and Gallatin Rivers and the mainstem Missouri where water temperature problems related to stream dewatering are known to occur and the East Gallatin River where chemical and organic pollution is a major concern.

(4) Wetted Perimeter Method

The instream flow needs for selected streams will be primarily quantified using a method employing a plot of wetted perimeter versus discharge for selected cross-sections within each reach. Wetted perimeter is the distance along the bottom and sides of a channel cross-section in contact with water. As the discharge in a cross-section of a stream channel decreases, the wetted perimeter also decreases, but the rate of loss of wetted perimeter is not constant over a given range of discharges. Starting at zero discharge, wetted perimeter increases rapidly for small increases in discharge up to the point where the stream channel nears its maximum width. Beyond this inflection point, the increase of wetted perimeter is less rapid as discharge increases. Data collected by the Montana Department of Fish, Wildlife and Parks indicate the discharge at which the inflection point occurs is generally a valid estimate of the discharge needed to maintain desirable standing crops of game fish.

The relationships between wetted perimeter and discharge for the stream reaches will be derived using a predictive wetted perimeter computer program developed for the Montana Department of Fish, Wildlife and Parks. Field survey data will be collected for approximately five cross-sections within a stream reach at two-three different flows. The program uses this data to predict the wetted perimeter for each cross-section at discharges selected by the investigator. Instream flow recommendations will be obtained from the plots of wetted perimeter versus discharge.

(5) Habitats and Species of Special Concern

Spring creeks will receive special consideration in Montana's instream flow program. Spring creeks in general are a highly utilized recreational resource that can provide outstanding habitat for trout and waterfowl. Due to the unique features of the spring creek environment and their high recreational value, all effort should be made to prevent the further degradation of the few remaining spring creeks in southwest Montana. Water withdrawals would only accelerate the demise of this already declining aquatic resource.

Streams that provide critical habitat for populations of arctic grayling and Missouri river cutthroat trout, species presently restricted to only a fraction of their former ranges, will also be given special consideration.

(6) Methodology Developed by the Cooperative Instream Flow Service Group (IFG)

Preliminary results of a study conducted by the Montana Department of Fish, Wildlife and Parks indicate that the IFG methodology in its present state of development is not a reliable method of deriving instream flows for the larger trout rivers of Montana. However, the method may be applicable to the smaller streams and creeks. The field data needed to run the IFG methodology on small streams will be collected concurrently with the data needed for the wetted perimeter method previously discussed. The IFG methodology will be used if future testing proves it is applicable to the smaller waterways.

The approaches tentatively chosen for deriving instream flow recommendations during the low flow period are outlined for each stream in Table 2. The status of the data needs for each approach is also identified. On some stream reaches instream flow needs have already been quantified and no additional data are needed.

Budget

The Montana Department of Fish, Wildlife and Parks is seeking supplementary funding to help finance projects in the Madison, Ruby and Beaverhead River drainages. Data collection in the other drainages was essentially completed during the 1979 field season using funds provided by the Department of Fish, Wildlife and Parks. Budgets for projects to be completed during the 1981 and 1982 fiscal years follow.

Table 2. Approaches to be used for quantifying instream flow needs for streams of the Missouri River drainage above Canyon Ferry Reservoir.

	Long-term Biol.-Flow Relationships	Short-term Biol.-Flow Relationships	Wetted Perimeter Method	Habitat and/or Species of Special Concern	Water Quality-Flow Relationships	Other
GALLATIN RIVER DRAINAGE						
Baker Creek			1			
Spanish Creek			1			
South Fork Spanish Creek			3			
Hell Roaring Creek			3			
Squaw Creek			3			
Swan Creek			3			
Moose Creek			1			
Portal Creek			1			
West Fork			3			
North Fork			1			
Middle Fork			1			
South Fork			1			
Porcupine Creek			1			
Beaver Creek			1			
Buck Creek			3			
Taylor Fork			3			
Cache Creek			3	3		
South Cottonwood			3			
Gallatin River (Mouth-E. Gallatin River)			1		2	
Gallatin River (E. Gallatin R.-Spanish Cr.)	3		3			
Gallatin River (Spanish Cr.-YNP Boundary)			1			
EAST GALLATIN RIVER DRAINAGE						
Rocky Creek			1		2	
Sourdough Creek			2		2	
Bridger Creek			1		2	
Hyalite Creek			2		2	
Reese Creek			1			
Ben Hart Creek				3		
Thompson Creek				3		
East Gallatin River (Mouth-Thompson Creek)			3			
East Gallatin River (Thompson Creek-Hyalite Creek)			3			
East Gallatin River (Hyalite Creek-Headwaters)					2	

Table 2 continued.

	Long-term Biol.-Flow Relationships	Short-term Biol.-Flow Relationships	Wetted Perimeter Method	Habitat and/or Species of Special Concern	Water Quality-Flow Relationships	Other
BIG HOLE RIVER DRAINAGE						
Willow Creek			1			
Trapper Creek			1			
Camp Creek			1			
Moose Creek			1			
Canyon Creek			1			
Divide Creek			1			
Deep Creek			1	2		
French Creek			1			
Pintlar Creek			1	2		
LaMarch Creek			1	2		
Fishtrap Creek			1			
Mussigbrod Creek			1	2		
North Fork Big Hole			1	2		
Trail Creek			1			
Ruby Creek			1			
Steel Creek			1	2		
Big Lake Creek			1	2		
Miner Creek			1	2		
Governor Creek			1	2		
Warm Springs Creek			1			
Wise River			1	2		
Pattengail Creek			1			
Swamp Creek			1			
Francis Creek			1			
Johnson Creek			1			
Big Hole River (Mouth-Old Divide Dam)	2		3		2	
Big Hole River (Old Divide Dam-Pintlar Creek)			2			
Big Hole River (Pintlar Creek-Headwaters)			3	3		
BEAVERHEAD RIVER DRAINAGE						
Poindexter Slough				3		
Blacktail Creek			1			
East Fork Blacktail Creek			1			
Grasshopper Creek			1		2	
Horse Prairie Creek			1			
Bloody Dick Creek			1			
Red Rock River (Mouth-L. Red Rock Lake)			2			
Red Rock River (L. Red Rock Lake-Headwaters)				2		
Big Sheep Creek			1			
Odell Creek				2		

Table 2 continued.

	Long-term Biol.-Flow Relationships	Short-term Biol.-Flow Relationships	Wetted Perimeter Method	Habitat and/or Species of Special Concern	Water Quality-Flow Relationships	Other
BEAVERHEAD RIVER DRAINAGE (Continued)						
Tom Creek				2		
Hellroaring Creek				2		
Antelope Creek				2		
Corral Creek				2		
Clover Creek			1			
Long Creek			1			
Beaverhead River (Mouth-Anderson Lane)			3			
Beaverhead River (Anderson Lane-Grasshopper Creek)			3			
Beaverhead River (Grasshopper Creek-Clark Canyon Dam)	3		3			
RUBY RIVER DRAINAGE						
Warm Springs Creek			1			
Middle Fork Ruby			1			
West Fork Ruby			1			
East Fork Ruby			1			
Ruby River (Mouth-Sheridan)			3		2	
Ruby River (Sheridan-Ruby Dam)			2			
Ruby River (Ruby Dam-Headwaters)			1			
JEFFERSON RIVER DRAINAGE						
Boulder River (Mouth-Big Spring)			3		2	
Boulder River (Big Spring-L. Boulder River)			1		2	
Boulder River (L. Boulder River-Bison Creek)			1		2	
Boulder River (Bison Creek-Headwaters)			1			
South Boulder River			1			
Willow Creek			1			
Whitetail Creek			1			
Jefferson River (Mouth-Mayflower Bridge)			3		2	
Jefferson River (Mayflower Bridge-Headwaters)			3		2	
MISSOURI RIVER DRAINAGE						
Crow Creek			1			
Dry Creek			1			
Deep Creek			1			
Duck Creek			1			
Confederate Gulch Creek			1			

Table 2 continued.

	Long-term Biol.-Flow Relationships	Short-term Biol.-Flow Relationships	Wetted Perimeter Method	Habitat and/or Species of Special Concern	Water Quality-Flow Relationships	Other
MISSOURI RIVER DRAINAGE (Continued)						
Beaver Creek			1			
Sixteenmile Creek			2			
Missouri River (Canyon Ferry Res.-Headwaters)		1	1		1	
MADISON RIVER DRAINAGE						
Cherry Creek			1			
Hot Springs Creek			1			
North Meadow Creek			1			
South Meadow Creek			1			
Jack Creek			1			
O'Dell Creek				3		
Blaine Spring Creek				3		
Indian Creek			1			
Ruby Creek			1			
Squaw Creek			1			
West Fork Madison			1			
Standard Creek			1			
Grayling Creek			1			
Duck Creek			1			
Cougar Creek			1			
South Fork Madison			3			
West Fork Denny Creek			3			
Watkins Creek			3			
Antelope Creek			1			
Cabin Creek			1			3
Beaver Creek			1			3
Madison River (Mouth-Ennis Dam)	3		3		2	
Madison River (Ennis Dam-McAtee Bridge)	3					
Madison River (McAtee Bridge-Quake Lake)	2		3			
Madison River (Quake Lake-Hebgen Dam)						3
Madison River (Hebgen Dam-YNP Boundary)			1			

1 No existing data
2 Additional data is needed to supplement existing data
3 Existing data is sufficient

Madison River Drainage

FY 1981

A.	Salaries and Benefits	
	Salaries (2 Grade 7/1 for 6 mos. each)	$ 9,720
	Benefits at 18%	1,750
		11,470
B.	Travel	
	5,000 miles at $0.20/mile	1,000
	Per Diem	2,500
		3,500
C.	Equipment	2,250
D.	Computer Time and Keypunching	1,500
E.	Repair and Maintenance	500
	Total Costs	19,220

Beaverhead and Ruby River Drainages

FY 1981

A.	Salaries and Benefits	
	Salaries (2 Grade 7/1 for 6 mos. each)	$ 9,720
	Benefits at 18%	1,750
		11,470
B.	Travel	
	5,000 miles at $0.20/mile	1,000
	Per Diem	2,500
		3,500
C.	Equipment	2,250
D.	Computer Time and Keypunching	1,500
E.	Repair and Maintenance	500
	Total Costs	19,220

All Waters Not Completed by FY 1981

FY 1982

A.	Salaries and Benefits	
	Salaries (2 Grade 7/1 for 6 mos. each)	$10,303
	Benefits at 18%	1,855
		12,158
B.	Travel	
	5,000 miles at $0.25/mile	1,250
	Per Diem	2,500
		3,750
C.	Equipment	1,000
D.	Computer Time and Keypunching	1,800
E.	Repair and Maintenance	1,000
	Total Costs	19,708

WATER ADJUDICATION UNDER PROVISIONS OF SENATE BILL 76

The Montana Department of Fish, Wildlife and Parks filed for instream water rights on sections of 12 rivers under provisions of Section 89-801 passed by the 1969 Montana Legislature. These filed rights are listed by river section in Table 3. As previously discussed, the Department is compelled to reaffirm our instream flow needs in response to the passage of Senate Bill 76 by the 1979 Montana Legislature. The Department is seeking supplementary funding to help finance projects on 6 of these 12 rivers. In the following section, background information, budgets, and the methods to be used for quantifying and supporting instream flow requests are presented for the six rivers.

Gallatin River

The free-flowing Gallatin River (Figure 2) originates at Gallatin Lake in Yellowstone National Park at an elevation of 8,834 ft. It flows north for approximately 115 miles to Three Forks, Montana where it joins the Madison and Jefferson Rivers to form the Missouri River. The river drains an area of about 1,800 square miles - all above an elevation of 4,000 ft. Most of the drainage basin above 5,000 ft is covered with coniferous forest and located within Yellowstone National Park and the Gallatin National Forest. The drainage basin below 5,000 ft consists primarily of the Gallatin valley, one of the richest agricultural regions in Montana.

Existing data are sufficient to quantify and support instream flow needs on the 50-mile segment of river between the Yellowstone Park boundary and the Beck-Border Ditch. Instream flow work for this project will be restricted to the segment of the Gallatin River between the mouth at Three Forks and the junction of the East Gallatin River.

The 10-mile segment of river between the mouth and the East Gallatin River flows through a narrow valley consisting of agricultural and grazing lands having an elevation less than 5,000 ft. Flow is confined to one or two channels. The streambed consists primarily of boulders, rubble, gravel and silt. The banks are primarily vegetated with willow and cottonwood. Debris piles, log jams, undercuts and long, deep pools provide much of the fish cover. Except for the East Gallatin River, tributaries are limited to a few spring creeks.

The mean discharge for a 61-year period of record at the USGS gage at Logan was 1,053 cfs. Flows ranged from 130 to 9,840 cfs. Peak flows occur in June. Flows at this gage reflect the dewatering that occurs during the summer irrigation season.

Water quality is presently considered good. This segment of river is slightly turbid year-round due to the sediment input from the East Gallatin River. In some summers, dewatering produces undesirable water temperatures and severely reduces the amount of living space available for fish.

Table 3. , Instream Water Filings Under Sec. 89-801 (RCM 1947)

Stream	Section	Amount (CFS)	Time Period
Big Spring Creek	From its mouth in T17N, R16E, Sec. 26 to mouth of Cottonwood Creek T16N, R17E, Sec. 28	150	1/1 to 12/31
Big Spring Creek	From mouth of Cottonwood Cr. in T16N, R17E, Sec. 28 to State Fish Hatchery in T14N, R19E, Sec. 5	120	1/1 to 12/31
Blackfoot River	From its mouth in T13N, R18W, Sec. 21 to mouth of Clearwater River in T14N, R14W, Sec. 16	2000 650	4/1 to 8/31 9/1 to 3/31
Blackfoot River	From mouth of Clearwater River in T14N, R14W, Sec. 16 to the mouth of its N. Fk. T14N, R12W, Sec. 9	1750 350	4/1 to 8/31 9/1 to 3/31
Flathead River	From its mouth in T27N, R20W, Sec.24 to the mouth of its S. Fk. T30N, R19W, Sec. 6	8125 3625	4/1 to 9/30 10/1 to 3/31
Flathead River	From mouth of S. Fk Flathead River T30N, R19W, Sec.6 to mouth of Middle Fk. Flathead River T31N, R19W, Sec.7	5000 1950	4/1 to 9/30 10/1 to 3/31
Flathead River	Flathead River from the mouth of Middle Fk. T31N, R19W, Sec. 7 to the mouth of Bowman Creek T35N, R21W, Sec. 22	2625 987.5	4/1 to 9/30 10/1 to 3/31
Flathead River	From mouth of Bowman Creek T35N, R21W, Sec. 22 to the Canadian Border	1500 625	4/1 to 9/30 10/1 to 3/31
Middle Fork Flathead River	From its mouth in T31N, R19W Sec. 7 to the mouth of Bear Creek in T29N, R15W, Sec. 31	2325 970	4/1 to 9/30 10/1 to 3/31

Continued

Table 3. continued

Stream	Section	Amount (CFS)	Time Period
Middle Fork Flathead River	From the mouth of Bear Cr. in T29N, R15W, Sec.31 to the mouth of Cox Cr. in T27N, R21W, Sec. 28	180 75	4/1 to 9/30 10/1 to 3/31
South Fork Flathead River	From its mouth in T30N, R19W, Sec. 6 & 7 to Hungry Horse Dam in T30N, R19W, Sec. 22 & 27	3000 1400	4/1 to 9/30 10/1 to 3/31
South Fork Flathead River	From the Powell-Flathead Co. line to its mouth at Hungry Horse Reservoir	1750 600	4/1 to 9/30 10/1 to 3/31
South Fork Flathead River	From its confluence with Danaher and Young's creeks in T20N, R13W, Sec. 36 to the Flathead-Powell Co. line	270 100	4/1 to 9/30 10/1 to 3/31
Gallatin River	From its mouth in T2N, R2E, Sec.9 to its junction with the East Gallatin River in T2N, R3E, Sec. 27	1500 800	5/1 to 8/31 9/1 to 4/30
Gallatin River (commonly called West Gallatin River)	From the Beck-Border Ditch intake in T25, R4E, Sec. 14 to Yellowstone Park boundary in T9S, R5E, Sec. 18	800 400	5/1 to 8/31 9/1 to 4/30
Madison River	From Ennis Lake to its mouth in T2N, R2E, Sec.17	1500 1200	6/1 to 12/31 1/1 to 5/31
Madison River	From mouth of W. Fork of Madison River in T11S, R1E, Sec. 10 to Ennis Lake	1400 900	6/1 to 12/31 1/1 to 5/31
Madison River	From Hebgen Dam to the confluence of the W. Fk of the Madison River in T11S, R1E, Sec. 10	500	1/1 to 12/31
Missouri River	Missouri River from mouth of Smith River in T19N, R2E, Sec. 9 to the Cascade-Lewis & Clark line in T16N,R2W,Sec.20	3000	1/1 to 12/31

Continued

Table 3. continued

Stream	Section	Amount (CFS)	Time Period
Missouri River	From the Lewis & Clark-Cascade Co. line in T16N, R2W, Sec. 19 to Holter Dam in T14N, R3W, Sec.8	3000	1/1 to 12/31
Missouri River	From Canyon Ferry Reservoir to Toston Dam in T4N, R3E, Sec. 7	4000 3000	5/16 to 9/14 9/15 to 5/15
Rock Creek	From its mouth in T11N, R17W, Sec. 12 to the mouth of Ranch Cr. in T10N, R17W, Sec. 25	300 1250	9/1 to 3/31 4/1 to 8/31
Rock Creek	Rock Creek from mouth of Ranch Cr. in T10N., R17W, Sec.36*to the junction of the east & west forks in T6N, R15W, Sec. 31. *(Not Sec. 36 but Sec. 25)	210 1125	8/1 to 3/31 4/1 to 7/31
Smith River	Smith River from the mouth of Hound Cr. in T17N, R3E, Sec.20 to the Cascade Co. line in T15N, R3E, Sec. 36	150 400	9/1 to 3/31 4/1 to 8/31
Smith River	Smith River from Meagher-Cascade Co. line in T14N, R3E, Sec. 1 to Fort Logan Bridge T11N, R5E, Sec. 31	125 150	9/1 to 3/31 4/1 to 8/31
Yellowstone River	From the mouth of the Stillwater River to the North-South Carbon-Stillwater Co. lines T3S, R21E, Sec. 10	2600 1500	4/16 to 10/31 11/1 to 4/15
Yellowstone River	From the mouth of Stillwater River to the mouth of the Boulder River	2200 1300	4/16 to 10/31 11/1 to 4/15
Yellowstone River	From mouth of Boulder River to mouth of Tom Miner Creek	2000 1200	4/16 to 10/31 11/1 to 4/15
Yellowstone River	From Yellowstone Park boundary to mouth of Tom Miner Cr. in T7S,R7E, Sec.30	800	1/1 to 12/31

Access to the lower river is readily obtained through some private lands; Fish, Wildlife & Parks access sites; and at bridge crossings.

Brown trout is the dominant trout species in the lower Gallatin River. Other game fish present include rainbow trout and mountain whitefish. Nongame fish present include white sucker, longnose sucker, mottled sculpin, longnose dace, and carp. The lower river still provides an adequate fishery for 1 to 2 pound brown trout in spring, early summer and fall in spite of environmental problems. Brown trout as large as 5-9 pounds are caught annually.

Fishing pressure in fisherman days for this 10-mile segment was estimated at 4,118 between May 1968 and April 1969 and 3,918 between May 1975 and April 1976 (MDFG 1969 and 1976). Nonresidents comprised about 12% of the pressure in 1975-76.

The bottomland along the lower Gallatin River supports huntable populations of mule deer, whitetail deer, ring-necked pheasant, and Hungarian partridge. Furbearers in the river bottom include beaver, muskrat, mink, otter, raccoon, red fox, and coyote. A great blue heron rookery is located along the river near Logan.

Methods

The following procedures will be used to obtain the data needed to derive and support instream flow needs.

I. The status of existing fish populations will be determined by estimating numbers and biomass in selected river reaches. Fish will be captured using a boat mounted electrofishing unit. The Petersen mark-recapture method will be used. These estimates will augment existing fish population data.

II. The instream flow needs for selected river reaches will be primarily quantified using a method employing a plot of wetted perimeter versus discharge for selected cross-sections within each reach. Wetted perimeter is the distance along the bottom and sides of a channel cross-section in contact with water. As the discharge in a cross-section of a stream channel decreases, the wetted perimeter also decreases, but the rate of loss of wetted perimeter is not constant over a given range of discharges. Starting at zero discharge, wetted perimeter increases rapidly for small increases in discharge up to the point where the stream channel nears its maximum width. Beyond this inflection point, the increase of wetted perimeter is less rapid as discharge increases. Data collected by the Montana Department of Fish, Wildlife and Parks indicate the discharge at which the inflection point occurs is generally a valid estimate of the discharge needed to maintain desirable standing crops of game fish.

The relationships between wetted perimeter and discharge for the river reaches will be derived using a predictive wetted perimeter computer program. Field survey data will be collected for approximately five cross-sections within a stream reach at two-three different flows. The wetted perimeter program uses this data to predict the wetted perimeter for each cross-section at discharges selected by the investigator. Instream flow recommendations will be obtained from the plots of wetted perimeter versus discharge.

Upper Missouri River

The following discussion pertains to the upper 45.5 miles of the Missouri River from its origin at the junction of the Madison, Gallatin, and Jefferson rivers to Canyon Ferry Reservoir (Figure 6). This section includes 20 miles of "Blue Ribbon" water.

The drainage area is 14,669 square miles (at Toston). Width of the channel ranges from 300 to 1,200 ft. The average gradient is 5.6 ft per mile and sinuosity is 1.6. The substrate ranges from sand-silt to cobble, but the majority is gravel-cobble.

Tributaries entering the Missouri in this section originate mainly from the east and most are totally diverted during the late summer for irrigation. These include Deep, Dry, Sixmile, Indian, Crow, Sixteenmile and Greyson creeks.

The natural flow patterns in this section have been altered by three upstream impoundments - Hebgen Reservoir on the Madison River, Ruby Reservoir on the Ruby River, and Clark Canyon Reservoir on the Beaverhead River. This section contains Toston Dam which is principally an irrigation reservoir. Toston Dam does not allow total regulation because of its small size.

The mean flow for a 42-year period of record at the USGS gage at Toston was 5,371 cfs. Flows ranged from 562 to 32,000 cfs. High water flows normally occur from April through July with peak flows occurring in June.

This section of river has good access for the recreationist. Public access points are especially well placed for floaters. These points include the Headwaters State Park at Three Forks, the Toston fishing access site, the Deepdale fishing access site, and the Townsend access. Floating is popular during the fall when excellent fishing for salmonids exists as well as good waterfowl hunting.

Riparian vegetation is limited to a narrow band along the river except for the lower 10 miles above Canyon Ferry Reservoir. In this area, the river channel is braided and the bottomland is extensively vegetated with willow and cottonwood.

The upper Missouri River is nationally known for producing trophy-size rainbow and brown trout. Current creel census results below Toston Dam show that rainbow and brown trout in the 17 to 22-inch class were commonly taken in 1978 with one brown trout reaching 8 pounds.

Population studies conducted during the fall of 1978 showed that large brown trout were present in the Toston Bridge to Deepdale area. Ten of the brown trout collected were over 5 pounds. Over 500 rainbow were sampled in the area from Townsend to Canyon Ferry Reservoir with many in the 17 to 20 inch class. In addition to substantial trout populations, this section also supports large numbers of mountain whitefish. Other fish present and their relative abundance are:

Cutthroat trout	rare
Brook trout	rare
Yellow perch	rare
Flathead chub	rare
Longnose dace	rare
Carp	abundant
White sucker	abundant
Longnose sucker	abundant
Stonecat	common

In addition to resident fish populations, the Missouri River from Canyon Ferry Reservoir to Toston Dam provides spawning and nursery areas for trout residing in the reservoir. Both brown and rainbow trout migrate into the river each fall, producing a trophy fishery. The fall run of rainbow trout produces an outstanding fishery. During the fall of 1978, 40% of the anglers censused had weight limits of rainbow trout (10 pounds plus one fish). Of a sample of 2,500 rainbow trout in the creel, 40% were in the 17 to 19 inch class with a few ranging to 25 inches and 8 pounds.

Between May 1975 and April 1976, the estimated fishing pressure for the upper 45.5 miles of river in fisherman-days was 7,705 (MDFG 1976).

Waterfowl use this section of the river during fall and spring migrations. That portion of the river just above Canyon Ferry Reservoir harbors extensive numbers of nesting ducks and geese. The security of nesting islands has been shown to be directly dependent on river flow.

Whitetail deer and ring-necked pheasant are abundant in the bottomland along this section. Other wildlife of particular interest are golden and bald eagles (both resident and migratory), osprey (6 to 7 nesting pairs), great blue heron (two large rookeries), and whistling and trumpeter swans (migratory). Furbearers include beaver, mink, muskrat and river otter. Common predators are red fox, coyote and raccoon.

Aquatic habitat conditions are generally good. River banks are stable and well vegetated. The dewatering of the river due to irrigation withdrawals is an occasional problem. The sediment input of tributaries and irrigation return flows in the Toston to Deepdale area is excessive. Elevated water temperatures are also a concern. Though the temperature data are not extensive, many days at 70 F and higher have been recorded. Temperatures above 70 F are generally considered undesirable for trout.

Instream flow work for this project will be restricted to the 20-mile "Blue Ribbon" portion of the upper Missouri River between Canyon Ferry Reservoir and Toston Dam. This project will augment ongoing studies on the upper river.

Methods

The following procedures will be used to obtain the data needed to derive and support instream flow needs.

I. The status of existing fish populations will be determined by estimating numbers and biomass in selected river reaches. Fish will be captured using a boat-mounted electrofishing unit. The Petersen mark-recapture method will be used. These estimates will augment existing fish population data.

II. An attempt will be made to determine the influence of flows on the selection of spawning sites of the migratory brown and rainbow trout populations from Canyon Ferry Reservoir. The object of this portion of the study will be to derive those flows needed to maintain desirable spawning conditions.

III. The instream flow needs for selected river reaches will be primarily quantified using a method employing a plot of wetted perimeter versus discharge for selected cross-sections within each reach. Wetted perimeter is the distance along the bottom and sides of a channel cross-section in contact with water. As the discharge in a cross-section of a stream channel decreases, the wetted perimeter also decreases, but the rate of loss of wetted perimeter is not constant over a given range of discharges. Starting at zero discharge, wetted perimeter increases rapdily for small increases in discharge up to the point where the stream channel nears its maximum width. Beyond this inflection point, the increase of wetted perimeter is less rapid as discharge increases. Data collected by the Montana Department of Fish, Wildlife & Parks indicate the discharge at which the inflection point occurs is generally a valid estimate of the discharge needed to maintain desirable standing crops of game fish.

The relationships between wetted perimeter and discharge for the river reaches will be derived using a predictive wetted perimeter computer program. Field survey data will be collected for approximately five cross-sections within a river reach at two-three different flows. The program uses this data to predict the wetted perimeter for each cross-section at discharges selected by the investigator. Instream flow recommendations will be obtained from the plots of wetted perimeter versus discharge.

Combined Budget for Upper Missouri and Gallatin River Studies

March 1 - June 30, 1980

A.	Salary and Benefits	
	Fishery Assistants (2 Grade 7/1 for 2 mos. each)	$ 2,978
	Benefits at 18%	536
		3,514
B.	Travel	
	2,500 miles at $0.18/mile	450
	Per Diem	400
		850
	Total Costs (March 1 - June 30, 1980	4,364

FY 1981

A.	Salary and Benefits	
	Fishery Assistants (2 Grade 7/1 for 4 mos. each)	6,432
	Benefits at 18%	1,158
		7,590
B.	Travel	
	5,000 miles at $0.20/mile	1,000
	Per Diem	800
		1,800
	Total Costs (FY 1981)	9,390

Continued next page

July 1 - December 31, 1981

A.	Salary and Benefits	
	Fishery Assistants (2 Grade 7/1 for 2 mos. each)	$ 3,434
	Benefits at 18%	618
		4,052
B.	Travel	
	2,500 miles at $0.25/mile	625
	Per Diem	400
		1,025
	Total Costs (July 1 - December 31, 1981)	5,077
	GRAND TOTAL COSTS (March 1, 1980 - December 31, 1981)	$18,831

Missouri River (Holter Dam-Smith River)

This section of the Missouri River, located between Holter Dam and the mouth of the Smith River, is 63 miles in length. The average channel width is about 400 feet. The average gradient is 3 ft per mile and the most common substrate type is sand and gravel.

Major tributaries entering the Missouri River in this reach include Sheep Creek, Dearborn River, Stickney Creek and Little Prickly Pear Creek (Figure 8). These streams add considerable flow to the Missouri during spring runoff but late summer and winter flow is largely insignificant to the river system.

This section of river flows through two distinct geologic zones. From Holter Dam to Sheep Creek, a distance of about 25 miles, the river flows through a mountain canyon having an average width of about 3,000 feet. A narrow band of riparian vegetation consisting primarily of willow and some cottonwood generally line the riverbanks. Several brushy islands are periodically found in this area. Below the confluence of Sheep Creek, the river abruptly leaves the mountain area and meanders through a wide and generally flat prairie zone. Several old oxbows have created shallow sloughs and backwater areas. Extensive growths of riparian vegetation consisting of a willow/cottonwood overstory accompanies the river floodplain through most of this area. Several brushy islands are also found throughout this portion of the river.

Flow is largely controlled by Canyon Ferry Reservoir, the largest of three consecutive upstream reservoirs. Canyon Ferry Dam was completed in 1953 by the Bureau of Reclamation for irrigation, power, flood control and recreation. Canyon Ferry has a full surface area of 35,200 acres and a storage capacity of 2,051,000 acre-feet. Hauser and Holter Reservoirs lie downstream of Canyon Ferry Dam and provide storage head for power generation. They are owned and operated by Montana Power Company.

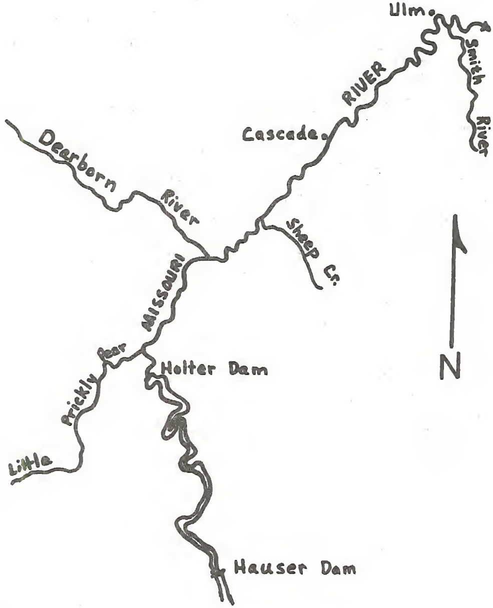

Figure 8. Map of Missouri River and tributaries between Holter Dam and confluence of Smith River.

This section of the Missouri River supports substantial cold-water fish populations and provides an excellent recreational fishery. Mountain whitefish, rainbow trout and brown trout are the most common sport fish. Many trophy trout from 5 to 10 pounds are taken each year. Mountain whitefish are very abundant and comprise an important winter fishery. A summary of catch statistics from anglers reporting their fishing trips through the Department's fisherman log program reveals excellent success. In 1976, 301 angler days yielded 875 rainbow trout, 113 brown trout and 515 mountain whitefish while in 1977, 299 days reported 831 rainbow trout, 180 brown trout and 1,085 mountain whitefish. Other fish species taken included brook trout, cutthroat trout, walleye, yellow perch, bullhead, burbot, longnose sucker, white sucker and carp.

An estimate of total fishing pressure on Montana waters was conducted for the 1975-76 fishing season. The survey revealed about 69,500 angler days were expended on this 63 mile section of river.

Access to the river is good. There are several public access areas along the upper half of this reach. Old U.S. Highway 91, now designated as a recreation road, parallels considerable portions of the river and also provides easy access. River flow is always good for floating and many recreationists take advantage of this sport. The outstanding scenery and fishing add to the enjoyment of this activity.

Many species of waterfowl are seasonally associated with the river. Mallards, mergansers, Canadian geese and teal nest along the river on islands, backwater areas and sloughs. Some mallards, goldeneyes and geese spend the winter along ice-free areas. During spring migration, the river is often an important resting area for thousands of pintails, mallards and other waterfowl enroute to northern nesting areas. Several species of shore birds such as killdeer, snipe, phalarope and gulls are also seasonally associated with the river.

The extensive riparian vegetation along the lower half of this section provides excellent habitat for many important wildlife species. Large numbers of white-tailed deer, mule deer and ring-necked pheasant are found the year-round. Small patches of riparian vegetation along the river in the mountain canyon area also provide habitat for a few deer. Mink, muskrat, beaver, raccoon and a few river otter are found throughout this reach. Bald eagles are often observed along the river corridor during the winter.

Methods

The following procedures will be used to obtain the data needed to derive and support the instream flow needs.

I. The status of existing fish populations will be determined by estimating numbers and biomass in selected river reaches. Fish will be captured using a boat-mounted electrofishing unit. The Petersen mark-recapture method will be used.

II. A survey will be conducted to measure recreational usage. Factors to be measured include angler harvest, composition and size of the fish creeled, catch rates, fishing pressure, and recreational floating.

III. The instream flow needs for selected river reaches will be primarily quantified using a method employing a plot of wetted perimeter versus discharge for selected cross-sections within each reach. Wetted perimeter is the distance along the bottom and sides of a channel cross-section in contact with water. As the discharge in a cross-section of a stream channel decreases, the wetted perimeter also decreases, but the rate of loss of wetted perimeter is not constant over a given range of discharges. Starting at zero discharge, wetted perimeter increases rapidly for small increases in discharge up to the point where the stream channel nears its maximum width. Beyond this inflection point, the increase of wetted perimeter is less rapid as discharge increases. Data collected by the Montana Department of Fish, Wildlife & Parks indicate the discharge at which the inflection point occurs is generally a valid estimate of the discharge needed to maintain desirable standing crops of game fish.

The relationships between wetted perimeter and discharge for the river reaches will be derived using a predictive wetted perimeter computer program developed for the Montana Department of Fish, Wildlife & Parks. Field survey data will be collected for approximately five cross-sections within a river reach at two-three different flows. The program uses this data to predict the wetted perimeter for each cross-section at discharges selected by the investigator. Instream flow recommendations will be obtained from the plots of wetted perimeter versus discharge.

Budget for Missouri River (Holter Dam-Smith River)

March 1 - June 30, 1980

A.	Salary and Benefits	
	Fishery Technician (Grade 10/1 for 4 mos.)	$ 3,838
	Benefits at 18%	691
		4,529
B.	Travel	
	2,000 miles at $0.18/mile	360
	Per Diem	400
		760
	Total Costs (March 1 - June 30, 1980)	5,289

Continued next page

FY 1981

A.	Salary and Benefits	
	Fishery Technician (Grade 10/1 for 12 mos.)	$12,201
	Benefits at 18%	2,196
		14,397
B.	Travel	
	5,000 miles at $0.20/mile	1,000
	Per Diem	1,200
		2,200
	Total Costs (FY 1981)	16,597

July 1 - December 31, 1981

A.	Salary and Benefits	
	Fishery Technician (Grade 10/1 for 6 mos.)	6,467
	Benefits at 18%	1,164
		7,631
B.	Travel	
	2,500 miles at $0.25/mile	625
	Per Diem	600
		1,225
	Total Costs (July 1 - December 31, 1981)	8,856
	GRAND TOTAL COSTS (March 1, 1980 - December 31, 1981)	$30,742

Supplementary Budget for Missouri River (Holter Dam-Smith River)

Recreational Use Inventory

A.	Salary and Benefits	
	Creel Clerk (Grade 8/1 for 3 mos.)	2,457
	Benefits at 18%	442
		2,899
B.	Travel	
	6,000 miles at $0.18/mile	1,080
	Per Diem	750
		1,830
	Total Costs (April 1 - June 30, 1980)	4,729

Continued next page

FY 1981

A.	Salary and Benefits	
	Creel Clerk (Grade 8/1 for 3 mos.)	$ 2,617
	Benefits at 18%	471
		3,088
B.	Travel	
	6,000 miles at $0.20/mile	1,200
	Per Diem	750
		1,950
	Total Costs (FY 1981)	5,038
	GRAND TOTAL COSTS (April 1 - September 30, 1980)	$ 9,767

Blackfoot River

The Blackfoot River originates near the Continental Divide at the confluence of Anaconda and Beartrap Creeks and flows 122 miles in a westerly direction to Bonner, Montana, where it joins the Clark Fork River. The river drains an area of about 2,320 square miles. Principal tributary streams in downstream order are: Alice Creek, Landers Fork, Nevada Creek, North Fork, Monture Creek, and the Clearwater River.

Agriculture and timber are the main industries of the Blackfoot valley. Most of the land adjacent to the river is private, mixed with some State and BLM land. There is very little National Forest land adjacent to the river, but a good share of the mountainous terrain is on National Forest land. Most surface water which makes up the Blackfoot River originates from tributaries which arise on and flow through National Forest land.

The Blackfoot River is, for all practical purposes, "free-flowing" from source to mouth. There is a small diversion dam at the mouth of the river which serves a wood products mill at Bonner. There is a small irrigation reservoir on Nevada Creek, a southern tributary. The Clearwater River flows through a series of natural lakes on its course down the valley. Waters of Landers Fork, North Fork and Monture Creek originate in wilderness or roadless areas. Logging activities are prevalent on both private and public lands in nearly every major subdrainage where this activity is allowed.

Hunting, fishing and other forms of recreation are important in the Blackfoot drainage. The Blackfoot River contains wild populations of rainbow, cutthroat, brook and brown trout, Dolly Varden, and mountain whitefish. Elk, mule deer, white-tailed deer and black and grizzly bears inhabit the drainage, as do three species of mountain grouse (blue, Franklin's, and ruffed).

Very little water is appropriated from the Blackfoot River at the present time. Water withdrawn from the stream is primarily used for private irrigation of pastures and haylands. An irrigation ditch about 1/8 mile below the mouth of Landers Fork diverts a significant amount of flow from the river during extreme low flow periods.

A principal state highway (Route 200) runs the length of the Blackfoot drainage, providing access to recreation areas as well as a main transportation route for local and commercial vehicles between Missoula and Great Falls, two of the larger cities in the state.

Methods

The following procedures will be used to obtain the data needed to derive and support instream flow needs.

I. The status of existing fish populations will be determined by estimating numbers and biomass in selected river reaches during the summer and fall months when flows are lowest. Fish will be captured using a boat-mounted electrofishing unit. The Petersen mark-recapture method will be used. Reaches to be considered for estimates are located near the mouth by Bonner and in the Ovando area below the mouth of the North Fork. Deep pools in other areas of the river may hinder the estimation of fish populations.

   On selected tributaries, estimates will be obtained for 1,000-ft sections. On streams where the numbers of trout are too low to obtain accurate estimates, survey data will be collected. In addition, selected streams will be electrofished in the fall and spring to evaluate spawning use by river fish populations. Some tributaries to be considered for population estimates and spawning evaluation are Gold Creek, Twin Creek, Monture Creek, the North Fork, and the Clearwater River.

   Population estimates for reaches of the Blackfoot and selected tributaries upstream of the North Fork are given by Spence (1975).

II. A survey will be conducted to measure recreational usage. Factors to be measured include angler harvest, composition and size of the fish creeled, catch rates, fishing pressure, and recreational floating.

III. The instream flow needs for selected river and tributary reaches will be primarily quantified using a method employing a plot of wetted perimeter versus discharge for selected cross-sections within each reach. Wetted perimeter is the distance along the bottom and sides of a channel cross-section in contact with water. As the discharge in a cross-section of a stream channel decreases, the wetted perimeter also decreases, but the rate of loss of wetted perimeter is not constant over a given range of discharges. Starting at zero discharge, wetted perimeter increases rapidly for small increases in discharge up to the point where the stream channel nears its maximum width. Beyond this inflection point, the increase of wetted perimeter is less rapid as discharge increases. Data collected by the Montana Department of Fish, Wildlife & Parks indicate that the discharge at which the inflection point occurs is generally a valid estimate of the discharge needed to maintain desirable standing crops of game fish.

The relationships between wetted perimeter and discharge for the stream reaches will be derived using a predictive wetted perimeter computer program developed for the Montana Department of Fish, Wildlife & Parks. Field survey data will be collected for approximately five cross-sections within a stream reach at two-three different flows. The program uses this data to predict the wetted perimeter for each cross-section at discharges selected by the investigator. Instream flow recommendations will be obtained from the plots of wetted perimeter versus discharge.

IV. The instream flow methodology developed by the Cooperative Instream Flow Service Group (IFG) of the U.S. Fish and Wildlife Service will be applied to some of the smaller tributaries if future testing proves the methodology provides reliable instream flow recommendations.

Budget for Blackfoot River Studies

March 1 - June 30, 1980

A.	Salary and Benefits	
	Project Coordinator (Grade 13/1 for 4 mos.)	$ 4,900
	Fishery Assistants (2 Grade 7/1 for 2 mos. ea.)	3,035
	Benefits at 18%	1,429
		9,364
B.	Travel	
	2,000 miles at $0.18/mile	360
	Per Diem	780
		1,140
C.	Equipment	
	Purchasing	750
	Rental	350
		1,100
D.	Repair and Maintenance	175
	Total Costs (March 1 - June 30, 1980)	11,779

Continued next page

FY 1981

A.	Salary and Benefits	
	Project Coordinator (Grade 13/1 for 12 mos.)	$15,483
	Fishery Assistants (2 Grade 7/1 for 6 mos. ea.)	9,720
	Benefits at 18%	4,537
		29,740
B.	Travel	
	5,000 miles at $0.20/mile	1,000
	Per Diem	2,340
		3,340
C.	Equipment	
	Purchasing	2,250
	Rental	1,000
		3,250
D.	Repair and Maintenance	500
	Total Costs (FY 1981)	36,830

July 1 - December 31, 1981

A.	Salary and Benefits	
	Project Coordinator (Grade 13/1 for 6 mos.)	8,206
	Fishery Assistants (2 Grade 7/1 for 4 mos. ea.)	6,869
	Benefits at 18%	2,714
		17,789
B.	Travel	
	2,500 miles at $0.25/mile	625
	Per Diem	1,365
		1,990
C.	Equipment	
	Purchasing	1,125
	Rental	500
		1,625
D.	Repair and Maintenance	250
E.	Computer Time and Keypunching	1,500
F.	Secretarial and Printing	1,500
	Total Costs (July 1 - December 31, 1981)	24,654
	GRAND TOTAL COSTS (March 1, 1980 - December 31, 1981)	$73,263

Smith River

The Smith River drainage lies in west central Montana, almost due south of Great Falls (Figure 9), between the Big Belt Mountains on the west and the Little Belt and Castle Mountains on the east. The drainage is approximately 75 miles in length and the width varies from 3 to 45 miles. The total area is slightly over 2,000 square miles. The elevation of the floor of the drainage varies from 3,350 to 5,400 feet above sea level. The highest mountain peaks range from 8,500 to 9,500 feet above sea level.

The Smith River is formed by the junction of the North and South Forks of the Smith River about 4 miles southwest of the town of White Sulphur Springs. The North Fork drains part of the southwest slopes of the Little Belt Mountains and the northwest slopes of the Castle Mountains. The South Fork originates along the southwest flank of the Castle Mountains and from the bench lands between the Castle and Big Belt Mountains. The mainstem of the Smith River then flows northwesterly through a narrow valley until it enters a deep mountain canyon about 10 miles north of Fort Logan. After emerging from the canyon, the river meanders through a relatively narrow valley flanked by rolling grasslands until it joins the Missouri River near the town of Ulm.

Numerous tributaries originate in the Big Belt and Little Belt Mountains to join the Smith River. Some of the major tributaries originating in the Big Belt Mountains are Birch, Camas, Beaver, Rock and Hound Creeks. Those from the Little Belt Mountains are Newlan, Sheep, Eagle, Tenderfoot and Deep Creeks.

Approximately 2,500 people reside within the Smith River drainage. A major highway system makes the area accessible to the surrounding urban areas which have a population of over 150,000 people.

In the early 1860's the discovery of gold in the surrounding mountains stimulated a heavy influx of miners. As gold was depleted and mining operations abandoned, farming and ranching began to take over as the predominant economy, and they remain so today.

The mean discharge of the Smith River for the 18-year period of record at the USGS gage near Eden (river mile 26) was 338 cfs. Flows ranged from 3.1 to 12,300 cfs. Flows at this gage reflect the dewatering that occurs during the summer irrigation season.

All waters in the Smith River drainage have been appropriated for irrigation and domestic use. As in other areas of the state, appropriations are several times the amount of water actually present. The dewatering of the Smith River during the summer irrigation season is probably the greatest factor limiting present game fish populations. The augmentation of summer flows by properly planned on or offstream storage facilities in the upper Smith River drainage is one possible solution for improving the fishery resource.

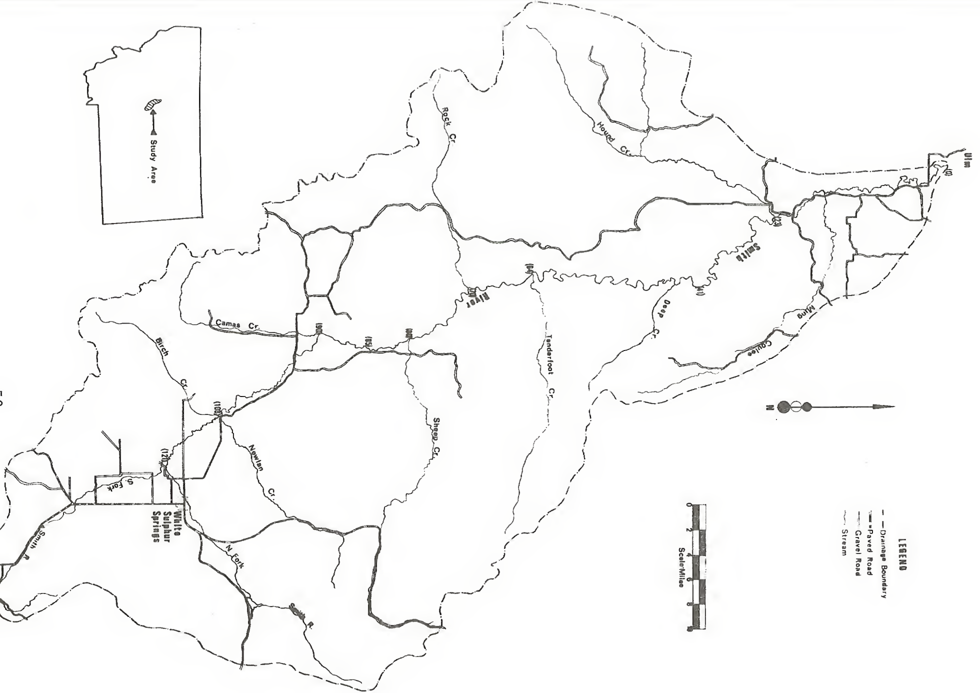

Figure 9. Smith River drainage. Approximate river miles in parenthesis.

Presently the water quality of the Smith River is generally good. A future threat to water quality is the poorly planned recreational homesite development that is occurring along the river. The loose alluvial materials found at many of the good construction sites will result in the rapid leaching of sewage effluent into the river.

Elevated summer water temperatures primarily resulting from dewatering and warm irrigation return flows are undoubtedly affecting the trout fishery of the Smith River. Temperatures above 70 F, which are considered undesirable for trout populations, commonly occur throughout the river. Water temperatures as high as 80 F have been recorded.

The annual sediment yield to the Smith River is considered moderately low. However, unnecessary seasonal sediment problems do occur. Severely gullied diversion ditches, early placer mining areas, raw banks along the rechanneled sections of the river, and land erosion resulting from the destruction of the protecting vegetative cover by overgrazing, extensive clearcut logging, road building and homesite development are some obvious sources of sediment to the Smith River drainage. Sediment adversely affects aquatic ecosystems in several different ways. For example, filling spaces between stones in the streambed gravels eliminates habitat for aquatic invertebrates. Sediment also interferes with trout egg incubation by restricting flow through the stream gravel, thus reducing the oxygen supply. There is some evidence of trout reproductive failure and low aquatic invertebrate populations in the upper half of the South Fork of the Smith River as a result of sediment pollution.

The Smith River offers sport fishing for rainbow trout, brown trout, mountain whitefish and an occasional brook and cutthroat trout. The mountain whitefish is the most numerous game fish. Rainbow trout, the predominant trout species, are the mainstay of the sport fishery throughout the river. The rainbow trout creeled by anglers rarely exceed 2 pounds with the majority in the 10 to 14-inch class. Brown trout, which provide the trophy fishery, commonly reach weights of 2 pounds with specimens up to 10 pounds reported. Other fish present include longnose sucker, white sucker, mountain sucker, longnose dace, stonecat, burbot, and mottled sculpin. A few carp are present in the lower river.

Limited public access strongly influences the recreational use of the Smith River. The river lacks the developed access sites and recreational areas that characterize many other rivers of Montana. As a result, float fishing and boating are the most popular recreational activities. The float season usually begins about the first of July after the crest of spring runoff and continues until about mid-August when water levels become too low for floating.

The Smith River still receives substantial angler use in spite of access and environmental problems. Fishing pressure in fisherman days was estimated at 11,217 between May 1, 1968 and April 30, 1969 and 10,924 between May 1, 1975 and April 30, 1976 (MDFG 1969 and 1975). Angler success is about three fish per angler per day.

The lands adjacent to the Smith River support a variety of wildlife. The canyon portion of the river provides winter range for mule deer and elk from the Big and Little Belt Mountains in addition to supporting a resident mule deer population. The canyon area also supports a variety of other wildlife associated with riverbottoms. White-tailed deer, ring-necked pheasant and sharp-tailed grouse are commonly found along the lower river where shrubby vegetation interspersed with agricultural lands provides excellent habitat.

Methods

The following procedures will be used to obtain the data needed to derive and support instream flow needs.

I. The status of existing fish populations will be determined by estimating numbers and biomass in selected river reaches. Fish will be captured using a boat-mounted electrofishing unit. The Petersen mark-recapture method will be used. These estimates will augment existing fish population data.

II. A general recreational use survey will be conducted to supplement existing data collected by the Montana Department of Fish, Wildlife and Parks and various federal agencies.

III. Discharges of the major tributaries to the Smith River will be monitored to determine the timing and magnitude of their flow contribution to the Smith River. It is anticipated that instream flow filings will be made on some tributaries in order to guarantee a minimum flow in the main river.

IV. The instream flow needs for selected river reaches will be primarily quantified using a method employing a plot of wetted perimeter versus discharge for selected cross-sections within each river reach. Wetted perimeter is the distance along the bottom and sides of a channel cross-section in contact with water. As the discharge in a cross-section of a stream channel decreases, the rate of loss of wetted perimeter is not constant over a given range of discharges. Starting at zero discharge, wetted perimeter increases rapidly for small increases in discharge up to the point where the stream channel nears its maximum width. Beyond this inflection point, the increase of wetted perimeter is less rapid as discharge increases. Data collected by the Montana Department of Fish, Wildlife & Parks indicate the discharge at which the inflection point occurs is generally a valid estimate of the discharge needed to maintain desirable standing crops of game fish.

The relationships between wetted perimeter and discharge for the stream reaches will be derived using a predictive wetted perimeter computer program. Field survey data will be collected for approximately five cross-sections within a river reach at two-three different flows. The program uses this data to predict the wetted perimeter for each cross-section at discharges selected by the investigator. Instream flow recommendations will be obtained from the plots of wetted perimeter versus discharge.

Budget for Smith River Studies

April 1 - June 30, 1980

A.	Salary and Benefits	
	Fishery Assistant (Grade 8/1 for 3 mos.)	$ 2,457
	Benefits at 18%	442
		2,899
B.	Travel	
	2,500 miles at $0.18/mile	450
	Per Diem	300
		750
C.	Equipment (Instantaneous readout current meter)	1,600
D.	Repair and Maintenance	100
	Total Costs (April 1 - June 30, 1980	5,349

FY 1981

A.	Salary and Benefits	
	Fishery Assistant (Grade 8/1 for 6 mos.)	5,233
	Benefits at 18%	942
		6,175
B.	Travel	
	5,000 miles at $0.20/mile	1,000
	Per Diem	600
		1,600
C.	Equipment	200
D.	Repair and Maintenance	200
	Total Costs (FY 1981)	8,175

Continued next page

July 1 - December 31, 1981

A.	Salary and Benefits	
	Fishery Assistant (Grade 8/1 for 3 mos.)	$ 2,773
	Benefits at 18%	499
		3,272
B.	Travel	
	2,500 miles at $0.25/mile	625
	Per Diem	300
		925
C.	Equipment	200
D.	Repair and Maintenance	100
E.	Computer Time and Keypunching	1,500
F.	Secretarial and Printing	1,500
	Total Costs (July 1 - December 31, 1981)	7,497
	GRAND TOTAL COSTS (April 1, 1980 - December 31, 1981)	$21,021

Yellowstone River

The Yellowstone River is free flowing over its entire length, making it unique among the large rivers of the continental United States. The Yellowstone originates in the northeast corner of Wyoming in Yellowstone National Park, and flows northeasterly through Montana before joining the Missouri River near Cartwright, North Dakota. It has a total drainage area of approximately 70,400 square miles, 35,900 of which lie in Montana. Its length from its headwaters in Wyoming to its confluence with the Missouri River in North Dakota is approximately 678 miles, 550 of which are in Montana.

Major tributaries entering the Yellowstone in Yellowstone Park include the Gardner and Lamar Rivers. In Montana, the only major south-flowing tributary to the Yellowstone is the Shields River near Livingston. Major north-flowing tributaries to the Yellowstone in Montana include the Boulder, Stillwater, Clarks Fork of the Yellowstone, Bighorn, Tongue and Powder Rivers (Figure 10).

The Yellowstone is of great importance as a sport fishery and can be divided into three general zones as related to fish distribution. From its headwaters in Wyoming to its mouth in North Dakota, the river changes from an alpine, salmonid-type fishery to a diverse, warm-water aquatic ecosystem.

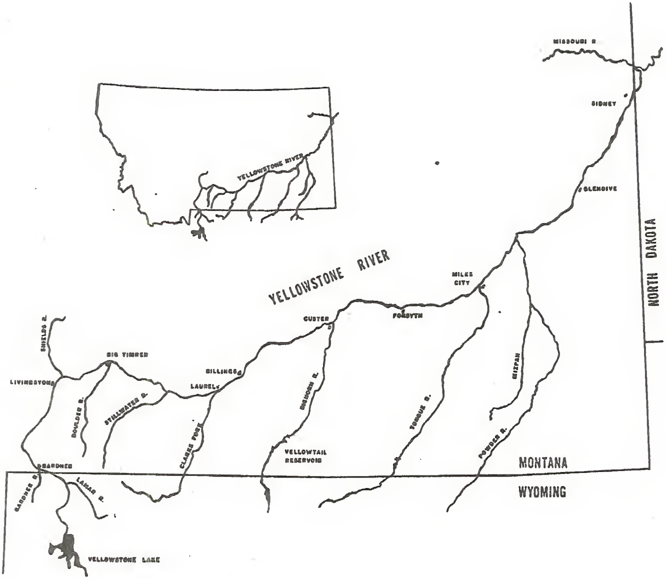

Figure 10. Yellowstone River drainage.

The upper Yellowstone, from Gardiner to Big Timber (111 miles), supports cold-water salmonid populations of national significance and has been classified as a "Blue Ribbon Trout Stream" by the Montana Fish and Game Commission. This area is characterized by large populations of a relatively small number of fish species characteristic of clear, cold-water rivers. The primary trout species are cutthroat, rainbow and brown trout. Large populations of mountain whitefish exist and longnose sucker are also abundant. The principal forage fish species is the mottled sculpin.

Flow regimens are monitored by U.S. Geological Survey gage stations at two locations on the mainstem of the upper Yellowstone. These are located at Corwin Springs and immediately upstream from Livingston at Carter's Bridge. The average annual discharge at Corwin Springs for a 67-year period of record was 2.25 million acre-feet (MAF), or 3,100 cubic feet per second (cfs). At Livingston, the average annual discharge (48-year period of record) was 2.70 MAF (3,700 cfs). The highest flow recorded at Livingston was 30,600 cfs (June 20, 1943), while the lowest recorded flow was 590 cfs on January 22, 1940. During the water year October 1972 through September 1973, the maximum recorded flow was 21,000 cfs (June 10, 1973) and the minimum flow was 1,250 cfs on December 8, 1972.

The middle Yellowstone, from Big Timber to the mouth of the Bighorn River (160 miles), contains the transition zone between the primarily cold-water environment of the upper river and the warm-water environment of the lower river. In this area, both cold and warm-water fishes are present, but their distribution and population dynamics are poorly understood.

The average annual discharge at Billings for a 45-year period of record was 4.97 MAF (6,862 cfs). The highest flow recorded was 66,100 cfs (June 16, 1967) while the lowest flow recorded was 430 cfs (December 12, 1932). During the 1972-73 water year, the maximum flow of 37,700 cfs was recorded on June 11, 1973, while the minimum flow of 1,100 cfs was on December 5, 1972.

The lower Yellowstone extends from the mouth of the Bighorn River to its confluence with the Missouri River and is approximately 295 miles long. This area supports a diverse aquatic ecosystem containing a wide variety of species commonly known as warm water fishes. Important sport species found in the lower Yellowstone include the paddlefish, shovelnose sturgeon, sauger, walleye, channel catfish, northern pike and burbot. In addition, large populations of nonsport species occur which represent a lightly utilized but potentially valuable resource.

Under Section 85-2-316 of the Montana Water Use Act, the Department of Fish, Wildlife and Parks was granted an instream flow reservation on the Yellowstone River. This instream reservation, however, is subject to legal challenge, periodic review and possible modification. Considering these limitations, the instream rights filed on the Yellowstone under Section 89-801, the so-called Murphy's Law, would likely be more secure. In addition, Murphy's rights for the Yellowstone have an earlier priority date (1970) than the reservations granted in 1978. The Department is, therefore, initiating a program to refile its existing "Murphy's" rights on the Yellowstone River.

Instream flow work for this study will be restricted to those portions of the upper and middle Yellowstone River between the Yellowstone National Park boundary and the Carbon-Stillwater County lines near Columbus. This study will augment ongoing projects on the upper and middle river.

Methods

The following procedures will be used to obtain the data needed to derive and support instream flow needs.

I. The status of existing fish populations will be determined by estimating numbers and biomass in selected river reaches. Fish will be captured using a boat-mounted electrofishing unit. The Petersen mark-recapture method will be used. Reaches of the Yellowstone to be considered for estimates are located between Springdale and Columbus, an area where population data are presently lacking. Between Springdale and the Yellowstone Park boundary, sufficient population data have already been collected.

II. A survey will be conducted to measure recreational usage. Factors to be measured include angler harvest, composition and size of the fish creeled, catch rates, fishing pressure, and recreational floating. The survey will be restricted to the portion of river between Springdale and Columbus. A recreational survey was conducted on the upper river above Livingston in 1979.

III. The instream flow needs for selected river reaches will be primarily quantified using a method employing a plot of wetted perimeter versus discharge for selected cross-sections within each reach. Wetted perimeter is the distance along the bottom and sides of a channel cross-section in contact with water. As the discharge in a cross-section of a stream channel decreases, the wetted perimeter also decreases, but the rate of loss of wetted perimeter is not constant over a given range of discharges. Starting at zero discharge, wetted perimeter increases rapidly for small increases in discharge up to the point where the stream channel nears its maximum width. Beyond this inflection point, the increase of wetted perimeter is less rapid as discharge increases. Data collected by the Montana Department of Fish, Wildlife & Parks indicate the discharge at which the inflection point occurs is generally a valid estimate of the discharge needed to maintain desirable standing crops of game fish.

The relationships between wetted perimeter and discharge for the river reaches will be derived using a predictive wetted perimeter computer program developed for the Montana Department of Fish, Wildlife & Parks. Field survey data will be collected for approximately five cross-sections within a river reach at two-three different flows. The program uses this data to predict the wetted perimeter for each cross-section at discharges selected by the investigator. Instream flow recommendations will be obtained from the plots of wetted perimeter versus discharge.

It may be possible to derive instream flow recommendations for the upper river using long-term fish population data collected in past years. A preliminary evaluation of this data indicates that the seasonal variations in the standing crops of trout within this reach are correlated with seasonal variations in river flow.

Budget for Yellowstone River Studies

March 1 - June 30, 1980

A.	Salary and Benefits	
	Fishery Technician (Grade 10/1 for 4 mos.)	$ 3,838
	Fishery Assistants (2 Grade 7/1 for 2 mos. ea.)	3,035
	Benefits at 18%	1,237
		8,110
B.	Travel	
	2,000 miles at $0.18/mile	360
	Per Diem	780
		1,140
C.	Equipment	750
D.	Repair and Maintenance	175
	Total Costs (March 1 - June 30, 1980)	10,175

FY 1981

A.	Salary and Benefits	
	Fishery Technician (Grade 10/1 for 12 mos.)	12,201
	Fishery Assistants (2 Grade 7/1 for 6 mos. ea.)	9,720
	Benefits at 18%	3,946
		25,867
B.	Travel	
	5,000 miles at $0.20/mile	1,000
	Per Diem	2,340
		3,340
C.	Equipment	2,250
D.	Repair and Maintenance	500
	Total Costs (FY 1981)	31,957

Continued next page

July 1 - December 31, 1981

A.	Salary and Benefits	
	Fishery Technician (Grade 10/1 for 6 mos.)	$ 6,467
	Fishery Assistants (2 Grade 7/1 for 4 mos. ea.)	6,869
	Benefits at 18%	2,400
		15,736
B.	Travel	
	2,500 miles at $0.25/mile	625
	Per Diem	1,365
		1,990
C.	Equipment	1,125
D.	Repair and Maintenance	250
E.	Computer Time and Keypunching	1,500
F.	Secretarial and Printing	1,500
	Total Costs (July 1 - December 31, 1981)	22,101
	GRAND TOTAL COSTS (March 1, 1980 - December 31, 1981)	$64,233

Budget
SB 76 Project Coordinator

January 1 - June 30, 1980

A.	Salaries and Benefits	
	Grade 15/1 for 6 mos.	$ 8,423
	Benefits at 18%	1,516
		9,939
B.	Travel	
	2,500 miles at $0.18/mile	450
	Per Diem	600
		1,050
	Total Costs (January 1 - June 30, 1980)	10,989

FY 1981

A.	Salaries and Benefits	
	Grade 15/1 for 12 mos.	18,193
	Benefits at 18%	3,275
		21,468
B.	Travel	
	5,000 miles at $0.20/mile	1,000
	Per Diem	1,200
		2,200
	Total Costs (FY 1981)	23,668

July 1 - December 31, 1981

A.	Salaries and Benefits	
	Grade 15/1 for 6 mos.	9,754
	Benefits at 18%	1,756
		11,510
B.	Travel	
	2,500 miles at $0.25/mile	625
	Per Diem	600
		1,225
	Total Costs (July 1 - December 31, 1981)	12,735
	GRAND TOTAL COSTS (January 1, 1980--December 31, 1981)	$47,392

ADDITIONAL YELLOWSTONE RIVER TASKS

When the Board of Natural Resources and Conservation signed the Order Establishing Water Reservations on the Yellowstone River, certain stipulations or conditions were attached which must be satisfied in order to maintain the reservation. Conditions 116, 117, and 121 of the Order pertain to instream flow reservations. Fulfillment of these conditions is primarily the responsibility of the Department of Fish, Wildlife & Parks, since we are the major holder of instream reservations in the Yellowstone Basin.

A major task under condition 116 involves the determination of the various percentile flow levels for streams which are not presently gaged or do not have that information available. The Board frequently granted a percentile flow as the reservation amount for a given stream and conditioned the applicant to determine what that percentile flow was. The first portion of this task is to develop a plan for obtaining these data, using methodologies acceptable by both USGS and DNRC. The second portion involves the actual establishment of stream gage sites, measuring of streamflow, calculation of flow duration hydrographs or generation of such data by alternate methodologies. The third phase is to present this flow information to the Board for approval.

Listed below is a summary of streams in the Yellowstone Basin where the Department will have to quantify the various flows that were granted:

Tributaries of the Tongue River - Hanging Woman, Otter and Pumpkin Creeks

Rosebud Creek

Tributaries of the Clarks Fork River - Butcher Creek, Willow Creek, West Fork of Stillwater, Little Rocky Creek, West Fishtail Creek, East Fishtail Creek, mainstem Fishtail Creek, West Rosebud Creek, East Rosebud Creek

Tributaries to the middle Yellowstone River - Bridger Creek, Lower Deer Creek, Upper Deer Creek, Sweet Grass Creek, Mission Creek, Little Mission Creek

Shields River at its mouth

Tributaries to the Shields River - Smith Creek, Flathead Creek, Cottonwood Creek, Rock Creek and Brackett Creek

Tributaries to the Yellowstone River above Livingston - Bear Creek, Cinnibar Creek, Mol Heron Creek, Cedar Creek, Tom Miner Creek, Rock Creek, Big Creek, Six Mile Creek, Fridley Creek, Eight Mile Creek, Mill Creek, Trail Creek, Suce Creek, Coke Creek, Billman Creek, and Fleshman Creek

The Spring Creeks of the upper Yellowstone - Armstrong Spring Creek, Nelson Spring Creek, McDonald Spring Creek, Emigrant Spring Creek

Another task in the NRC Board Order is outlined in condition 117. Here the reservant shall submit to the board an annual progress report on the status of all work required to be performed in accordance with condition 116, dealing with determination of streamflows. The annual progress report shall contain all information relating to pursuing the goals of the instream reservation. This annual progress report is required until all work under condition 116 is completed.

Condition 121 specifies that the board shall periodically, but at least once every 10 years, review the reservation including reports and other plans to insure that the objectives of the reservation are being met. It is our responsibility under this condition to document, support and prove that the objectives of the instream reservation are indeed being met. This will probably be done through biological investigation, monitoring fish populations,reproduction, etc., involved with the instream flows and submitted to the board at the time of review.

Work Plan to Determine Various Percentile Flows (Condition 116)

Task 1. Assemble and evaluate available information and data.

1. Drainage physical characteristics (e.g., climate topography)
2. Water usage to determine appropriate level of development (e.g., municipal, agricultural, etc.)
3. Select appropriate modeling technique
4. Identify sites where stream gaging will be necessary

Task 2. Development of Flow Duration Hydrographs.

1. Implement stream gaging on those sites identified in task 1.
2. Generate and evaluate flow duration hydrographs for all streams

Task 3. Report.

1. Introduction stipulating the purpose of the investigation
2. Summary of data and information used in the investigation
3. Methodologies and assumptions employed in development of the flow duration hydrographs
4. Results, including tables of the flows for the granted percentiles on the various streams

Budget

A cost estimate of $76,400 was submitted by a private consulting firm to complete the tasks in condition 116. This estimate includes personnel, computer and travel costs. The Department is presently seeking additional bids.

TOTAL COSTS FOR PLAN IMPLEMENTATION

	Cost
Upper Missouri River Drainage	
Madison River Drainage	$ 19,220
Beaverhead and Ruby River Drainages	19,220
All waters not completed by FY 1981	19,708
Water Adjudication Under Provisions of Senate Bill 76	
Upper Missouri (Headwaters-Canyon Ferry Dam) and Gallatin Rivers	18,831
Missouri River (Holter Dam-Smith River)	30,742
Recreational use inventory Missouri River (Holter Dam-Smith River)	9,767
Blackfoot River	73,263
Smith River	21,021
Yellowstone River	64,233
SB 76 Project Coordinator	47,392
Additional Yellowstone River Tasks	
Determine various percentile flows (Condition 116)	76,400[a]
	$399,797

[a] - Preliminary bid

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